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To Florence, from Horace

January 10, 1935.

Too bad you couldn't
contribute to this topic!

TWINS: HEREDITY AND ENVIRONMENT

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Illustration of the two extremely different types of twins. The center pair of children look no more alike, and are no more alike, than ordinary sisters.

TWINS

HEREDITY AND ENVIRONMENT

BY

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NATHANIEL D. M. HIRSCH

DECEMBER 31, 1929

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TWINS: HEREDITY AND ENVIRONMENT

CHAPTER I

INTRODUCTION

THE study of twins is equally interesting to the layman and to the scientist. This is a happy circumstance, for there are few media offering so excellent an approach to the problems of heredity and environment as is afforded by the scientific investigation of twins. In view of the universal interest in twins the author has attempted to present the following study in as nontechnical a form and style as possible, in the hope that the study may reach some small part of the educated public as well as the specialist.

To essay to write for two types of readers is a hazardous task, but it seems to the author that the vital need of presenting all possible knowledge of the complicated interrelationships of heredity and environment in human affairs to as large a number of intelligent persons as possible makes apologies superfluous. Yet he is constantly mindful that in writing for the two types at the same time he resembles the tight-rope walker learning to combine his feat with juggling.

The distinction between the constitutions with which we are born and the environment in which we are placed, with the relative contribution of each to our life-histories, has been considered for centuries. How far is man the creature of his racial and family background,

and how far is he the product of his physical environment, social *milieu* and contemporary educational ideals? How far may original nature be modified and molded by social nurture? Implicitly or explicitly the answer to such questions has in great part determined man's social, political, and economic philosophy.

In the past, emphasis has been largely placed on environment. For twenty-four centuries many leading thinkers believed that species might be transformed by environmental changes, and argued also that even the organic had arisen from the inorganic through the juxtaposition of exceptionally favorable environmental conditions. When environmental agencies were believed to be responsible for the origin of life itself and for the main deviations and transformations of species, much more could environment direct and mold the growth of the individual.

But the apotheosis of environment was not reached until the seventeenth and eighteenth centuries, when many philosophical writers taught that man was entirely the product of his physical, social, and educational environments, and that innately all men were equal. Differences among men were deemed to be entirely due to dissimilarities in their environments.

Our own Declaration of Independence mirrors this spirit. To declare it self-evident "that all men are created free and equal" is to assert that we all start life with similar or even identical heredities. This doctrine was one of the most cherished ideologies of the nineteenth century. Upon the belief in the intrinsic equality

of man, systems of theology arose, and educational and political ideals were promulgated which hold sway to a great extent even now. Most of our social institutions rest upon the belief that men are fashioned by their environment rather than motivated and controlled by hereditary impulses.

But for the last quarter of a century, due to a great extent to the study of genetics and in part to the development of modern psychology, the greater importance of heredity has been emphasized and urged. Some of the principles and modes of inheritance have been discovered, and the nature and extent of the feeble-minded ascertained. It is also generally agreed by anthropologists, anatomists, and biologists that the species *homo* has changed little in the last thirty thousand years; certainly there has been no perceptible improvement in the human species during the last seven or eight thousand years, the historical period. And there are many modern tendencies, largely arising during the last century, that are positively lowering the average innate psycho-biological equipment of the human race and eliminating the production of great positive deviants, geniuses.

We shall offer no summary of the studies demonstrating the truth of the latter statement. But all of them tend to show that natural selection, which for æons eliminated the dysgenic and preserved the best and most fit, has been nullified by the standards and efforts of civilized man, to such an extent that today it is probable that the unfit survive and reproduce them-

selves in greater numbers than the best. The development of benevolence is patently one of civilization's greatest achievements, and the mistake has been, not in nullifying natural selection, but in failing to substitute artificial social selection in the perpetuation of man. For centuries the worst stocks have reproduced their kind, having the full approval of religious, economic, and political institutions; and indeed such institutions have often actively exploited the tendency of the defective, the vicious, and the diseased to breed, thereby obtaining religious subjects, military recruits, and willing serfs and workers. During this same time the noble and talented have tended toward extinction by celibacy; by continuous wars; by miscegenation; by persecution, imprisonment, and exile; and by luxury, vice, and disease with its attendant sterility and infertility.

It is becoming increasingly evident that all men are born *unequal*. Even "identical" twins have germinal differences; at least they are somewhat unequal at birth. Men are equal, however, in two ways: they are, as Henry Van Dyke stated, exactly alike in that they are all different; and they are equal in the common rights of man—the right to life, liberty, and the pursuit of happiness.

Outside these equalities, men are intrinsically, profoundly, unalterably unequal and unlike. One of the most important discoveries of modern psychology and biology is that the more you educate men the more unequal they become. The more common opportunities they have the less common and equal are their achieve-

ments and mental statures. The more equal and general the culture bestowed upon men the more dissimilar and more differentiated are their lives and productions.

But we must not leave the reader with the belief that heredity and environment are antagonistic principles. The truth lies at the opposite extreme. Their functions and values are intricately interwoven, and a correct social philosophy would use them both coöperatively. But this is far from predicating that they are equally valuable in their contributions. Indeed, the main portion of our study confirms the opposite view, in quantitative and objective terms.

I. Previous experimental studies on twins have been based on *unselected* twin subjects. This is true of each of the three studies having a large number of cases, those of Thorndike, Merriman, and Lauterbach. Also all three of these studies, although assuming either two or more kinds of twins, have discovered no certain criteria for separating twins of one type of genesis from those of another type. The present study is based on a procedure which dispenses with the question of origin of twins altogether, without, however, in the least undervaluing them as a means of unique approach to the relative merits of heredity and environment.

Our groups of twins, on the contrary, were *selected* twins, chosen from a much larger total body of twins by conscious, intentional elimination. We intentionally selected only those twins who were very similar, and those twins who were very dissimilar but of the same sex. This last point, too, characterizes this study of

twins. For unlike twins of opposite sexes may be, in great or little part, unlike just because of sex, and the disentangling of sex differences from differences arising from hereditary but non-sexual factors is both a gratuitous and an impossible task.[1]

Summarizing at this point: the two main groups of the twins constituting our data are (1) twins selected on a basis of great similarities versus great differences, and (2) twins selected on a basis of dissimilarity, but of the same sex, so as to eliminate differences arising from sex.

II. We shall now endeavor more concretely to picture the method and meaning of our approach to the problem of heredity and environment through the study of twins.

Having selected two large groups, one of very similar twins and the other of very dissimilar twins, we measured them for six mental and anthropometric characters. For the moment let us center on one character, intelligence, as expressed in terms of Intelligence Quotients, and proceed with our argument.

Both groups of twins have similar environments. The average likeness of the environments for each pair of similar twins corresponds with the average likeness of each pair of dissimilar twins; and the average difference of environments for each pair of similar twins corresponds with the average difference of environment for each pair of dissimilar twins; that is, the environments

[1] The means by which we selected similar and dissimilar twins is described on pp. 53–54.

of both kinds of twins are similar for each pair of twins, and may therefore be ruled out as a factor accounting for differences in the degree of resemblances between the two kinds of twins. In other words, if we concede that environment accounts for all of the differences between the I.Q.'s of individuals of each pair of similar twins, we can account for only the same amount of I.Q. difference in dissimilar twins. Any greater difference in the latter kind of twins must be attributed to non-environmental or hereditary factors. Thus, suppose that the average I.Q. difference discovered to exist between the individuals of similar twins is 2 + I.Q. points and between the individuals of dissimilar twins is 12+ I.Q. points. If we concede that all the difference between the individuals of similar twins is determined by environment, the latter is only equally effective in determining the difference between the individuals of dissimilar twins;[1] that is, environment determines but two of the twelve I.Q. points which constitute the average difference between individual twins of the dissimilar group, and heredity determines ten I.Q. points; or heredity is five times as potent in its contribution to I.Q. differences.

Expressing our argument somewhat differently, we inquire, How shall we account for six times as great a difference in respect to I.Q. standing in one group of twins as compared to another? Theoretically, either environment or heredity accounts for this phenomenon. But the former is excluded as a factor determining the

[1] See page 50.

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greater difference in the one group than in the other, since the environment of each pair of twins of both groups is common to both members (of each pair of twins). Hence heredity must explain five sixths of the average difference of I.Q. standing.

That the genesis and biological type of a pair of twins cannot be absolutely ascertained is indicated in the writings of Professor H. H. Newman, probably the world's greatest authority on the biology of twins. He writes:

> The armadillos furnish two strangely unique situations quite opposite in character. In *Dasypus* there is the splitting up of a single egg into a number of separate embryos, while in *Euphractus* two originally separate eggs *secondarily undergo extensive fusion of their membranes so as to produce monochorial twins quite deceptively like those known to be monozygotic.*[1]

Later in this same volume Professor Newman states:

> A general summation of resemblances is more likely to be a sound basis (for distinguishing identical from fraternal twins) than any single detail could be, especially since we know that monozygotic armadillo quadruplets often differ markedly among themselves in respect to characters of strictly comparable nature.

That is to say, even individuals whose zygotic origin is known to be from an identical root differ widely at birth.

[1] *The Biology of Twins*, p. 6. The italics are mine.

CHAPTER II

MONSTROSITIES AND TWINS

WITH primitive peoples, monstrosities and twins were often associated and confused. This was undoubtedly one of the causes for the aversion of primitive peoples to twins, and the cause of their belief that the appearance of twinning was an ill omen for the gens or tribe. The modern man considers twinning as natural and as normal as single birth, the deviation from normality being entirely a matter of infrequency.

Monsters and monstrosities have had a peculiar hold on the minds of peoples. The mythologies and literatures of all nations are filled with them. Myths of sirens, satyrs, Cyclops, Janus, and corresponding figures in Celtic, Teutonic, and Scandinavian mythologies have faint anatomical analogues in biological monstrosities.

It is convenient and useful to group monstrosities roughly on the basis of single and double ones, and to proceed in each class from those monsters in which the whole embryo is involved to those in which but a part of it is affected. As single monstrosities are only aberrants from normal single births, our interest does not lie primarily in them.

Single monstrosities are sometimes divided into two sub-classes: first, those in which there is a failure to de-

velop a part of the body or an organ. This is termed aplasia or agenesia; for example, the legs or arms may be entirely lacking. Second, those monstrosities in which an organ or part exists, but fails to develop; it remains small and relatively useless, functionally considered. This is termed hypoplasia. A common example is the hypoplasia of the aorta in *status lymphaticus.*

Common examples of single monstrosities of the aplasia or agenesia type are: absence of the lower jaw, agnathia; absence of the vault of the skull, cranioschisis; the rudiments of the two eyes fused and occupying a common orbit, synophthalmia or cyclopia; and the two kidneys merged and grown together in the so-called "horseshoe" kidney.

Examples of single monstrosities of the hypoplasia type are: the mouth represented by a small opening; the ears perhaps very small and placed low down; an improper development of the spleen, adrenals, lungs, pancreas, fingers, or toes; in the last two cases there may be complete or partial fusion of these members. Other more common exemplifications of hypoplasia malformations are "clubfoot," "clubhand," and "harelip."

Single monstrosities that are a concomitant of twin births are an intermediate phenomenon between such single-birth monstrosities as have just been considered, and "double monsters." Homologous twins are always of the same sex.

If both develop normally they usually closely resemble each other. But the individuals, if born alive, often do not develop

equally; one may be less well nourished than the other, from a disturbance of the vascular supply, for example.

One of the twins may die early in pregnancy and suffer varying degrees of degeneration into a shapeless mass, or may die later and be born prematurely or at the delivery of the living twin. Some of these abortive forms are without a heart or have only a rudiment of that organ. These are called acardiac monsters. They may consist of connective tissue, rudimentary bones, and portions of intestine, and be covered by skin with hair — *acardiacus amorphus.* Or there may be a more or less distinctly formed head without a corresponding trunk — *acardiacus acormus.* There may be a fairly well developed trunk with viscera and a rudimentary heart, but no head — *acardiacus acephalus.* Finally, there may be a relatively well developed trunk with defective extremities and a rudimentary heart — *acardiacus anceps.*

In all of the above *duplications* the fusion is confined to the *placenta and its appendages*, the bodies of the twins being separate.[1]

We have briefly discussed types of single monsters, accompanying single and duplicate births. A third type of monster, double monsters (*monstra duplica*), are more pertinent to our study.

Double monsters are pathological deviants from identical twins, where the embryos themselves are joined in some form of union. The embryos may be symmetrically united and developed, or one of the individuals may be arrested in its development.

Symmetrically developed individuals may be united in the thoracic region. The ensiform processes are united by cartilage, the union of the soft parts extending

[1] Delafield and Prudden, *Text of Pathology* (12th ed., revised by F. C. Wood), pp. 362–363. The italics are mine.

over the umbilical region. This form of union is called xiphopagus. The famous Siamese Twins are an example of this class. In other cases there is a common thoracic cavity, and generally there are two hearts and two pairs of lungs, more or less malformed; the intestines in these cases are usually common to the twins. These monsters are called thoracopagis.

Sometimes the faces of twins are joined together. Sometimes the heads are united — craniopagus. This fusion is generally of the cranial bones only. Again, twins are sometimes united in head and neck, looking in opposite directions — janiceps or Janus-faced. Lastly, twins may be united posteriorly in the region of the sacrum and coccyx. This abnormality is called pygopagus. Such twins may live for many years.

But double monstrosities may be also unsymmetrically fused, or one of the twins may be unsymmetrically developed, while the other is normal in its development. The arrested twin is joined to the normal as a part of a living organism, and its life is maintained by the normal relative; the former is called the parasite, the latter is termed the autosite. The parasite may be variously developed; its size and differentiation vary immensely — all the way from formless appendages to a creature almost as large but not so well developed as the autosite.

After this short review of single monstrosities, of single monstrosities accompanying duplicate birth, and of double monstrosities, it is pertinent to inquire how double monsters are related to our subject of twins. It has been noted that primitive peoples associated them

to the extent of sometimes confusing and identifying twins and double monsters. This identification was due to the fact that both are duplicate births in contrast to the familiar and usual single births that universally prevail in the species *homo sapiens.*

Double monsters are germane to our subject of twins, then, in the merely superficial aspect of duplicate births. But more importantly they are connected by the facts of heredity. Both double monsters and twins originate by virtue of inherited tendencies in the sperm or ovum rather than because of environmental factors, either in the external world or in environmental factors in the womb surrounding the ovum. Double monsters are due to primary changes in the germ; that is, the tendency to duplicate births is an inherited tendency.

The production of single monsters is probably due to an inherent tendency in the fertilized ovum, for it is well known that a woman who gives birth to a monster is likely to do so a second time. However, some pathologists urge that single monsters may be due to a diseased condition in the uterus which interferes with the implantation of the ovum, and that with double monsters the monster part may likewise be due to diseased uterine conditions; yet it is almost universally accepted that the "doubling" part is an inherited tendency. Nevertheless, it must be added that mechanical external means have been used to produce double monsters. Driesh, Loeb, Wilson O. Schultze, and others have experimentally produced double monsters by mechanical, chemical, or thermal means. It does not seem that the

mechanical production of double monsters undermines the theory which maintains that an inherited tendency in the fertilized ovum accounts for twinning. The artificial production of doubling is, however, evidence that living creatures are considerably more plastic than the radical hereditist is willing to admit.[1]

Double monsters are germane to our inquiry secondly by reason of the frequent disparity between the two embryos, or between the two monster individuals. That is, "identical" or homologous twins, even at the moment of their origin, may differ considerably in innate tendencies; and by virtue of the period of intrauterine life these initial innate differences may be accentuated and deepened. Thus, by the time of birth,

[1] A recent contribution to the nativistic theory of the origin of single monsters and pathological deviants is the following:

"I understand that the theory has recently been advanced that those monsters which have been thought to owe their origin to causes already existing in the germ (primary germ variation, inheritance, atavism) in reality have as their causative factor some endocrine disturbance on the part of the mother. With reference to these conflicting ideas, the following report may be of interest: Mrs. W. F., aged thirty-four, at her fourth confinement, and two weeks before term, was delivered of twin boys. The first-born of the twins was a pronounced micromelus with cretin-like features. This boy lived about three hours. The second, born one hour later, was normally developed and is living and well. The approximate weights were $5\frac{1}{4}$ and $4\frac{3}{4}$ pounds respectively. These were double ovum twins, the placentas were entirely separated, and each placenta was extruded after the birth of the corresponding fetus.

"There is no history of previous malformations in the family of either parent. The children of the three earlier pregnancies, aged twelve, seven, and four years, are normally developed, as are the parents. It would not seem possible that any endocrine influence could so grossly affect one twin and leave the other unharmed." — B. R. Sleeman, M. D., Linden, Michigan, *Journal American Medical Association*, December, 1927.

so-called "identical twins" may differ considerably from each other.

The importance of this truth and its ramified implications will be referred to several times in a later part of our study.

CHAPTER III

SUNDRY FACTS CONCERNING TWINS

TWINS remain interesting to modern man despite the loss of wonder and superstition regarding their origin. For a deviation like multiple birth in a species that reproduces itself generally by single birth rarely fails to excite curiosity and interest in human beings; it arouses their imaginations and often their romantic tendencies. Twins figure in art, in literature, in humor, in advertising, as they formerly served as objects of legends, myths, and superstitions.

The proportion of twins in ratio to the general population discloses another interesting case of the disparity between general opinion and scientific fact. The writer has questioned half a dozen educated persons regarding the percentage of twins. Their answers have ranged from one in a thousand to one in ten thousand!

In Prussia, between the years 1826 and 1849, the proportion of twin births was one in eighty-nine. In the United States registration area in the year 1917, the data on 1,339,975 births showed twin births in one out of ninety-three cases. That is to say, one individual out of every forty-five to forty-seven is of twin origin.

It has been discovered that the ratio of twin births to triplet births is the square of the ratio of twins to the general population; that is, if $1:n$ is the ratio of twins

to the general population, $1:n^2$ is the approximate ratio of triplets to the general population. Thus the ratio of twins in the 1917 United States registration was $1(93)^1$; the ratio of triplets was $1:(93)^2$ (1 in 8649 births).

"From the statistical relations it would appear that triplets are produced by the coincidence of two independent processes occurring with equal frequencies. One of the processes by itself gives rise to twins."[1]

In the 1917 census of births, thirty-six cases of quadruplets occurred (in 1,339,975 births). This actual ratio was $1:(71.9)^3$, a somewhat greater number than expected, if the number of quadruplets bears the same ratio to the number of triplets that the latter bears to twins.

Somewhat allied to the percentage of twins to the general population is the question of the 4 of like-sex pairs of twins to twins of unlike sex. The sex-ratios of 718,000 pairs of twins was ascertained by Nichols. Their numbers and percentages follow:

	Males	Mixed	Females
Number	234,497	264,098	219,312
Per cent	88	100	83

Miss Margaret Cobb has also collected data on the sex-proportions of pairs of twins.[2] Her data follow:

	Males	Mixed	Females
Number	1,118	1,193	1,023
Per cent	93	100	87

[1] Charles Zeleny, "Relative Number of Twins," *Science*, March, 1921.

[2] "Evidence bearing on the Origin of Human Twins from a Single Ovum," *Science*, April, 1915.

This ratio of like-sex twins to twins of unlike sex has been utilized in an attempt to prove that there are two sorts or two kinds of twins determined by their biological mode of origin. The argument runs thus: If all twins originate from two *separate* fertilized ova, then it is merely a matter of chance whether an individual of a pair of twins is to be male or female, since the sexes are almost equally distributed. That is, in every twin birth there would be two chances that the individuals would be of unlike sex to one chance that they would both be male, or to one chance that they would both be female. The ratio would be 1:2:1. This means that there would be one pair of boys, to two mixed pairs, to one pair of girls.

But the data of Nichols and Cobb reveal that approximately only thirty-seven per cent of all pairs of twins are of the same sex. Hence the difference between the greater actual ratio and the lesser theoretical ratio is explained by assuming that one fourth of all twins are derived from a single fertilized ovum.

Until recently the twofold origin of twins has received support from the belief that one could tell the origin of twins by an examination of the membranes which enclose them. But it has been rather convincingly shown that the single-placenta test is not infallible as a sign of single-egg origin. There are cases of fused membranes which appear to be single, but which are actually double. But more important are the reverse conditions reported by many obstetricians: multiple membranes, but one-egg origin. Whether twins are identical or not

cannot, then, be infallibly detected by means of the placenta.

On the whole the twofold origin for twins, with a general classification of twins into two distinct types, has been accepted by biologists, embryologists, obstetricians, and psychologists. These two distinct types are (1) fraternal twins, who may or may not be of the same sex, and whose degree of resemblance or disparity varies very widely, but who are presumably derived from two separate eggs; (2) duplicate twins, who are always of the same sex, closely resemble each other, and are generally believed to originate from only one fertilized ovum which divided into two nearly identical portions sometime during the early development of the segmenting ovum, or by the cleavage of the embryonic area.

The argument for the two distinct species of twins arising from the sex-ratios of pairs of twins has already been set forth. We will now consider certain other facts that lend force to the dual-origin theory of twins.

Bateson defined twinning as "the production of equivalent structures by division," and maintained that this type of production was a fundamental fact of nature. Professor Newman also regards twinning as "a very fundamental process almost universal in the field of biology. For wherever we have bilateral doubling, we have twinning in some form." Dr. Arnold Gesell accepts the latter quotation from Newman. He states that

> from this point of view, every bilateral individual may be conceived as being morphologically a pair of twins. This

view is so legitimate that it need not be called paradoxical. The human individual is undoubtedly derived from a single fertilized cell. He is monozygotic in origin. From this zygote, through a process of symmetrical division, develop all his right and left hand homologous organs and the right and left halves of his "unpaired" organs and structures. He is a product of developmental duplicity. Now in the case of true, complete monozygotic twins, this process of duplication has been carried to such a degree that two offspring result from the single ovum. A perfectly symmetrical bilateral individual on the one hand, and a perfect pair of duplicated individuals on the other, represent the ideal extremes of the process of twinning. Between the extremes there are many gradations and deviations, some of them benign, others monstrous, in character.[1]

Dr. Gesell has also suggested that hemi-hypertrophy is an imperfect form of twinning; it is a deviation from the same process which may produce a completely symmetrical individual, or identical twins, or a double-headed monster.

Sometimes the disparity of the two sides of a hemi-hypertrophical individual is so great that there will be eight teeth on the enlarged side when none have erupted on the other; as though the individual had two physiological ages, or as though he were two different, conjoined hemi-creatures.[2]

Gynandromorphism (in which an animal is male on one side and female on the other) and the various forms of double monsters mentioned in the preceding chapter, as well as the bilaterality of normal individuals, and hemi-hypertrophy, must all be considered as instances of monozygotic twinning. When we compare almost

[1] "Mental and Physical Correspondence in Twins," in *Scientific Monthly* (May, 1922), pp. 417–418. [2] *Ibid.*

perfect duplicate twins with monsters of the autosite-parasite type it is seen that twinning produces both the extreme similarities and the extreme disparities in nature.

> Nowhere in the study of man do we find such complete duplication of the individuality as among monozygotic twins; and nowhere do we find also such profound and monstrous degrees of individual difference as among twins of monozygotic origin.[1]

In opposition to all these data giving evidence of the dual origin of twins are the arguments and data of Thorndike, who doubts whether there are two modes of fertilization and genesis of twins. His data on fifty pairs of twins show no division into two distinct types, "for the closest likeness grades off gradually into notable difference as one ranks twin pairs by their resemblance." Even the most similar twins differ singularly in some traits. "The most identical twins will in *some* respect be less like each other than ordinary siblings."

Thorndike's arguments against the genesis of any considerable percentage of twins by the division of one fertilized ovum are:

> First, this specialization (of resemblance), which is well nigh universal; second, the non-appearance of any such well-defined group of especially similar twins; third, the fact of triplets, all three as identical as any twins; fourth, the too great frequency of close resemblance.

R. A. Fisher in England, utilizing Thorndike's data, accepted a unimodal skewed curve as representing the

[1] *Ibid.*, p. 421.

resemblance that exists between twin pairs. But he explains this distribution by predicating a third mode of genesis of twins. He says:

> The fact that the observations examined critically show themselves to be a strictly homogenous population, with correlation much larger than that between sibs, requires a new theory of the genetic connection between twins. It is here suggested that the facts may be explained by the supposition that twins ordinarily share the hereditary nature of one gamete but not of the other.

Continuing, Fisher states that

> if we suppose that in certain cases the ovum after maturation is induced to divide into two identical portions, which are fertilized by different spermatozoa, not only is the observed resemblance of twins numerically explained, but the influence of the father is open to reasonable explanation.[1]

Thus three modes for the germinal genesis of twins have been offered by scientists:

(1) Two ova fertilized by two spermatozoa.
(2) The cleavage of an ovum fertilized by one spermatozoön.
(3) An ovum, divided into two identical portions, fertilized by different spermatozoa.

But the degree of resemblance between individuals of a twin pair is further complicated by diverse post-germinal and developmental factors. Their combined actions may obscure the germinal tendencies to resemblance or to difference between the individuals of a twin pair; so that in some cases, twins identical *germinally* may be

[1] "The Genesis of Twins," *Genetics*, September, 1919.

less alike than twins originating from two sperms and two ova, or from two sperms and one ovum. Lastly, we must recognize with Williams as quoted by Gesell, that even

single ovum twins may be produced in one or all of as many as four different ways:

(1) By fertilization of two polar bodies.
(2) By premature separation of one or more blastomeres from a segmenting ovum.
(3) By cleavage of the embryonic area.
(4) By double gastrulization of the blastodermic vesicle.

Boveri has suggested the additional possibility — actually demonstrated on eggs of sea urchins and bees — that a sperm may occasionally unite with only one half of a precociously divided ovum, leaving the other half to develop parthenogenetically.[1]

Summarizing briefly the last few pages: the degree of specialization or resemblance between individuals of a twin pair causally considered is most complicated. The degree may be almost entirely germinally grounded according to whether the pair originated from two ova separately fertilized, or from one fertilized ovum, or from one ovum divided and fertilized by two separate spermatozoa; if the origin is from a single fertilized ovum, differences in degree of resemblance may be occasioned by as many as four variations in the production of single-ovum twins. Lastly, post-germinal and developmental factors, such as early differences in somatic divisions (Newman's theory of somatic segre-

[1] Arnold Gesell, "Mental and Physical Correspondence in Twins," *Scientific Monthly*, May, 1922.

gation) may cause great differences between identical twins, or striking similarities in twins derived from two ova, or from one ovum fertilized by two sperms.[1]

Does the fact of twin origin, uterine development, and birth operate to lower the *intellectual* level of twins in comparison with the general non-twin population? The popular conception apparently is in the affirmative. Twins have been thought to be less capable mentally than the general population.

But in the admirable study of Dr. Curtis Merriman [2] no reliable mental difference between an unselected twin group and Terman's study of 905 unselected children was discovered. The slight difference of two points in the I.Q. medians cannot be interpreted as showing twin inferiority, for various studies of unselected groups have exhibited only slight variations in the median I.Q. Dr. Merriman's conclusions are that twins suffer no handicap in intelligence.

Although Professor Merriman has discovered that twins are mentally normal this fact will not dispel a deep-set public opinion that usually one individual of human twins is stronger, healthier, and more energetic than the other member of the pair. This prevailing view appears to be founded on facts, for there are considerable data showing that during pregnancy one twin may harm the other, to some extent at least.

[1] The relevancy and relationship of the modes of origin of twins to our own experimental data will be shown in Chapter IV.

[2] "The Intellectual Resemblance of Twins," *Psychological Monographs*, 1924.

The biological disadvantages twins suffer may be divided into two kinds, general handicaps and specific handicaps. Both monozygotic and dizygotic twins develop in a uterus which has been evolved for, and is adapted to, the gestation of one fetus at a time. Twins, whatever their origin and kind, must occupy the space normally evolved and fitted for one fetus: they therefore not only crowd each other, but must compete for a single food supply.

In addition to this handicap common to all twins, monozygotic twins suffer from the fact that there is intercommunication between placental vascular systems, a condition which Schatz calls "the third circulation." If this intercirculation is symmetrical neither twin is hurt, but if the arterial contribution of one twin is greater than the other's, or if the venous contribution of one is less than the other's, serious injury may be done both to the "favored" and to the "injured" twin. For this reason intra-uterine death occurs much more frequently with monozygotic twins than with ordinary twins. Professor Newman, quoting Schatz, states that

> intra-uterine death in one-egg twins occurs three times as frequently as in two-egg twins. This seems to indicate that a high percentage of the prenatal deaths of one-egg twins is to be attributed to the influence such twins exert upon each other through their intimate vascular interrelations.[1]

That twinning among human beings has a hereditary basis has been fairly definitely ascertained. Twins appear far more often in certain strains of the general

[1] H. H. Newman, *The Physiology of Twinning*, p. 147.

population than in others, although the ability to produce twins is probably common to all strains. C. H. Danforth found that fifty pairs of newborn twins had 171 singly born brothers and sisters, a ratio of 1 : 18. Further, in respect to the mothers of these twins, their brothers and sisters numbered 318 single births and ten pairs of twins, a ratio of 1 : 32. Lastly, the fathers of the fifty pairs of twins had 219 brothers and sisters, born singly, and eight pairs of twin brothers and sisters, a ratio of 1 : 37. When we remember that the normal ratio of twin to single in the population at large is approximately 1 : 93, the hereditary tendency towards twinning in specific lines is easily perceived.

But whether the tendency to twinning resides in the father or in the mother is not known; indeed, it is possible to be determined by either, or by both. Further, the tendency to duplicate or identical twinning may be determined by one parent, and the tendency to "fraternal" twinning may be determined by the opposite parent.

Professor Newman quotes a very interesting case of pronounced twinning which indicates (in this case at least) that the twinning diathesis resides in the father.

> The case concerns a man whose first wife had quadruplets once and twins ten times; his second wife had triplets three times and twins ten times. The man was the father of sixty-eight children. Dr. Berger (who discovered the case) inferred that the tendency to twinning is due rather to the father than to the two mothers. How such a condition could be determined by the male is difficult to imagine, but it may well be that the tendency to polyembryonic development of an egg

might be stimulated by some peculiarity of the sperm. If the twins in this case were all duplicates this would be an interesting possibility; but the father could hardly control double or triple ovulation in the mother. Unfortunately no data are given as to the sex of the twins in this striking case.[1]

It is highly doubtful whether mankind regards twinning as such a boon that certain lines would intermarry because of their twinning tendencies. But in cattle the utility is obvious, and twin-bearing lines could probably be brought about by selective breeding. Some biologists are inclined to regard twinning in cattle and in man as a recessive, and single births as dominant. If this is true, a pure twinning strain could possibly be produced by interbreeding homozygous recessive individuals, that is, persons of both sexes whose parents and grandparents were themselves twins.[2]

It is probable that twin births occur occasionally in all ruminant animals, although they normally produce but a single offspring at birth. But the most interesting and singular type of twins among mammals is the so-called freemartin, which has been comprehensively treated by Professor Newman in his *Biology of Twins.*

There are four types of bovine twins: (1) two normal males, (2) two normal females, (3) a male and a female, both normal, (4) a normal male with a freemartin. As to the nature of the freemartin there have been a variety

[1] *The Biology of Twins*, pp. 123–124.

[2] The phenomenon of twinning also seems to be a specific hereditary character of certain strains of sheep. For an interesting summary of Alexander Bell's experiment on twinning in sheep, see H. H. Newman, *The Biology of Twins*, pp. 119–121.

of interpretations. Only recently Professor F. R. Lillie has discovered the true nature of the freemartin.

The freemartin has attracted the attention of observers for a century and a half. John Hunter (1786) appears to have been the first person to approach the problem objectively. Newman stated that Hunter's view, namely, that the freemartin is a transverse hermaphrodite with a varying predominance of the two sexes, was the classical one, and went unchallenged for some time.

A. Numan (1843) concludes that the freemartin ranges from a slightly abnormal female type, in which the development of the female organs has been retarded and assumes an immature expression, to those freemartins which have apparently developed male characters.

O. Spiegelberg (1861), still according to Newman, gives us a third view of the freemartin. His conclusion was that the freemartin is not an imperfect or sterile female, but an imperfect male.

D. Berry Hart (1910) gives us a view of the freemartin similar to Spiegelberg, but considers it and its normal male twin as derivatives of a single fertilized egg, that is, as duplicate twins. He states:

> It seems to me, therefore, fully established that the freemartin, when the co-twin of a potent male, is a sterile *male* and not a sterile female: i. e., they are identical twins except in their genital tract and secondary sexual characters.[1]

[1] *Proceedings of Royal Society of Edinburgh,* vol. XXX. Quoted by Newman.

SUNDRY FACTS CONCERNING TWINS

Professor Lillie's recent study on the embryology of twins in cattle has solved the question as to the nature of the freemartin. He has demonstrated that the latter is a sterile female whose gonads remain in the juvenile stage so that they resemble testes, and who has certain secondary sexual characters of the male due to the presence for a considerable period of male hormones in the blood borrowed from its male co-twin. The animal is a hermaphrodite only in a very limited sense. The work leaves no question as to the dizygotic origin, not only of opposite-sexed but also of same-sexed bovine twins.[1]

In man as well as in all mammals the ratio of male to female births is slightly in favor of the former, usually in the ratio of from 105 to 108 male births to 100 female births. But in the case of twin and multiple births the ratio decreases until in that of quadruple births it is reversed. Nichols gives the following table, applying to man:

	Number of Sons per 1000 Daughters
Single births	1,057
Twin births	1,043
Triple births	1,007
Quadruple births	548

E. N. Wentworth found a similar ratio for sheep. In 115 multiple births in sheep he discovered the following sex-ratios:

	Cases
3 males to a birth	16
2 males and 1 female to a birth	39
2 females and 1 male to a birth	22
3 females to a birth	38

[1] *The Biology of Twins*, p. 107.

In summarizing his work he finds that in multiple births the ratio of females to males is 197: 148.

The only reason known for this reversed disparity of males and females in plural birth is the one advanced by Professor Newman and others: a sex-difference in prenatal mortality. "It is well known that the prenatal mortality of human males is greater than that of females, an indication that males are less resistant to abnormal uterine conditions than are females." But "that the mere fact of multiple offspring carries with it no necessary disturbance of sex-ratios is seen when the ratios of normally multiparous species are examined." Wentworth gives data showing that for dogs and swine there is no significant departure from the normal distribution of the sexes.

From these two sets of facts it seems that the reversal of normal sex-ratios in plural births is confined to those species that are normally uniparous, and in which the fetal development of males is unusually precarious.

The *biological* study of twins is especially enlightening in regard to both sex *determination* and sex *differentiation.* Sex is presumably determined in many species ascending from worms to man, at the time of fertilization. In some species, sex is determined by or within the egg, some of the eggs producing males, others producing females. In other animal forms the determination of sex is more complicated: if the eggs develop parthenogenetically, that is, without being fertilized by sperms, they all result in females; but if they are

fertilized, about half of the resulting creatures are male, and about half female.

In still other cases, notably the hymenoptera, *males* are produced when the eggs are *not* fertilized and females when the eggs are fertilized. All of these apparently divergent phenomena are consistent with the idea that sex is determined in the germ cell and that the sex-determining factor is in some way intimately associated with the presence of a peculiar chromosome (the X chromosome), or group of chromosomes, in the nucleus of the germ-cell. This mechanism gives a sex bias to the individual, a bias in some cases so strong that no known factors can interfere with the fulfillment of the sex development that was originally determined. In other cases, however, sex may be zygotically determined, but requires a definite favorable environment to bring it to complete development or differentiation. Finally, in some cases the individual which is zygotically sex determined may have its sex development so altered as to become largely of the opposite sex.[1]

Now how does the biology of twins enlighten us upon the problem of sex determination? By the fact that the eggs of two species of armadillo, divided at any early period into two or more embryonic primordia, *always* produce individuals all of the same sex.

In hundreds of sets of quadruplets in the Texas armadillo there has occurred no exception to this rule, in spite of the fact that in some cases there are marked differences in size due to unequal environment factors. . . . Similarly in man, twins that are monochorial and in other ways bear evidences of monozygotic origin are always of the same sex.[2]

[1] *The Biology of Twins*, p. 111.
[2] *Ibid.*, p. 112.

Lastly, when we turn to a creature as far removed from man as the parasitic hymenoptera the same phenomenon is observed. Silvestri found in the genus *Litomastix* that

> a single egg divided very early into a large number of separate embryonic primordia, each of which produces an adult insect. No matter how many individuals are derived from one egg, — the number may be even a thousand, — they are of the *same* sex.[1]

How does the biology of twins enlighten us in regard to the problem of sex differentiation? The facts regarding the freemartin demonstrate that although sex is zygotically determined in mammals, the *differentiation* and development of sex-characters depend on the internal secretions of the sex glands, and perhaps to some extent on the amount and rhythm of secretion of all of the ductless glands.

In the case of the freemartin, there is an individual zygotically determined to be a female twin, and becoming almost male in character owing to the influence of the male-hormone-charged blood of its brother-twin.

It is generally known that a castrated or ovariotomized young mammal does not develop the natural characters of its sex, remaining a neuter, although hereditarily determined to be either a male or female. Steinach's work goes nature one better, for his transplantation of ovaries into young castrated rats radically altered the nature of the animals, which assumed many of the characters of the female rat; the reverse also was

[1] *The Biology of Twins*, p. 113.

done—ovariotomized females became large and masculine when testicular substance was transferred to them.

Not only is a *psychological* study of twins a crucial method for approaching the problem of heredity and environment, which is the main problem of this present little volume, but the biology and psychology of twins might well serve as the foundation of many of the other problems of psychology, among the most important of which is the nature of mind and the relation of mind and body, a problem with a history of nearly three thousand years — "solved" today by the behaviorists by dropping the notion of mind and consciousness altogether. To most of us, however, the problem remains genuine — and vital.

The point here then is that in the case of identical twins, triplets, or quadruplets we find several individuals originating from a spermal penetration of an ovum which usually results in only one individual. There is no reason to believe that if the uterine conditions permitted, identical offspring would be limited to quadruplets. An egg of the hymenoptera *Litomastix* divides very early into hundreds of individuals, each of which is of the same sex, and all of which are very similar to one another. Our interest, however, for the time is limited to the actual facts of human identical births — twins, triplets, quadruplets. In such cases, several individuals, as normal mentally as the general population (Curtis Merriman) originate from an impetus, a living cell, which, if the mechanics were different, might equally be either one human being or several hundred.

The present study is largely an experimental undertaking, and we must now refrain from further comment along these lines, but the subject might give both vitalists and mechanists pause.[1]

The extensive studies of the late Professor Wilder on skin patterns of human palms and human soles include observations upon twins. He found that the fingerprints of no two individuals were alike in all details, but that the resemblances between the friction skin patterns of many "identical" twins were very close. Great similarity of friction skin patterns of twins does not, however, demonstrate monozygotic origin, and lack of very close resemblance does not prove the dizygotic origin of twins. As we have mentioned before, there is neither a single proof nor a composite proof of the genesis of any specific pair of twins.[2]

Professor Newman cites one of the most striking cases discussed by Wilder. One of them is a case of triplets, two boys and a girl.

> The palm-prints of the girl are no more like those of the two boys than is usually the case for ordinary brothers and sisters, but those of the two boys are extraordinarily similar. It may be decided that the two boys are monozygotic and that the girl was derived from a separate zygote.[3]

[1] These ideas are expanded at some length in my forthcoming volume, *An Introduction to Metabiology.*

[2] For this reason we approached the problem of hereditary versus environmental influence in twins by an entirely different method.

[3] *The Biology of Twins*, pp. 158–159.

Another very interesting case studied by Wilder and cited by Professor Newman was a pair of "conjoined" twins.

These twin girls (Margaret and Mary) were observed a day or two after birth and are now over four years old. (They are united in the sacro-iliac region but are placed somewhat obliquely, so that instead of looking in opposite directions they are rotated about 45 degrees toward the same side.) A study of their palms and soles was deemed of great interest, since there appeared to be no question as to their monozygotic derivation. The palms of all four hands are practically alike in pattern; the right hand of each one not only mirrors its own left hand but also the left hand of its twin partner. Since there is no asymmetry in the hands, there is no chance to observe symmetrical reversal or mirror imaging. Strange to say, however, although both sole patterns of Mary and the left one of Margaret are alike, the right sole-print of Margaret has a totally different configuration. The left sole of Mary and the right sole of Margaret are more nearly identical than are the right and left soles of Margaret, which is a good case of mirror-imaging and just the kind of thing one might look for in conjoined twins. Quite unexpected, however, is the occurrence of the odd pattern in the right sole of Mary. . . .

The case is one of very special interest, since it is the only one of twins on record where the embryonic membranes were studied in correlation with the somatic resemblances. It was ascertained that "there was a single chorion without trace of a separating partition, and the placenta was bilobed, and nearly as large as two normal placentae." The umbilical cord was single for 11 cm. from the placenta, forking into two branches, one a little larger than the other, running to the two individuals.[1]

[1] *Ibid.*, pp. 164–166.

The tendency to twinning and the tendency to left-handedness have some causal association. Whether twinning tends to cause left-handedness or vice versa, or both are conditioned by a common cause, is unknown. However, that these two tendencies are clearly found together is undeniable. Left-handedness is found in about four per cent of the population at large. Twins, it will be recalled, form less than two per cent of the general population. Yet Lauterbach found at least nineteen per cent of his twin pairs had one left-handed member.

In our own data, among fifty-eight pairs of dissimilar twins, seven pairs (12 per cent) were found to have one left-handed member; among the forty-three pairs of similar twins eighteen had left-handed members (42 per cent). The percentage of left-handed members of all 101 pairs is 25 per cent. The much greater proportion of left-handedness among our similar twins seems more significant to us (42 per cent instead of 12 per cent) than the fact that left-handedness is *six* times as frequent among twins as in the population at large.

CHAPTER IV

A REVIEW OF SOME EXPERIMENTAL STUDIES UPON TWINS

I

ALTHOUGH twins have aroused the curiosity, wonder, and interest of mankind for thousands of years, the first experimental study upon them was made less than fifty years ago. Sir Francis Galton made a general comparison of two groups of twins: one group contained thirty-five pairs of very similar twins; the other group consisted of twenty pairs of markedly unlike twins.[1]

Galton's study was primarily undertaken as an investigation of the relative influence of heredity and environment in determining human personality and conduct. He summarizes his results thus:

> We may, therefore, broadly conclude that the only circumstance, within the range of those by which persons of similar conditions of life are affected, that is capable of producing a marked effect on the character of adults is illness or some accident that causes physical infirmity. The impression that all this leaves on the mind is one of some wonder whether nurture can do anything at all, beyond giving instruction and professional training. There is no escape from the conclusion that nature prevails enormously over nurture when the differences of nurture do not exceed what is commonly to be found among persons of the same rank of society and in the same country.

[1] *Inquiries into Human Faculty.*

TWINS

II

Professor Thorndike's famous study on fifty pairs of twins, appearing in the *Archives of Philosophy, Psychology, and Scientific Methods* (September, 1905), is well known and only one sentence from his conclusions will be cited. In close agreement with Galton, Thorndike states:

> The facts then are easily, simply, and completely explained by one simple hypothesis: namely, that the natures of the germ cells — the conditions of conception — cause whatever similarities and differences exist in the original natures of men, that these conditions influence body and mind equally, and that in life the differences produced by such differences as obtain between the environments of New York City public school children are slight.

Professor Thorndike's results may roughly be summarized as follows: (1) Older twins, those from twelve to fourteen years of age, were found to be no more alike than twins from nine to eleven years of age, although they ought to have been if environment were effective in molding the natures of children. (2) The likeness between fifty pairs of twins, and it must be remembered that they were not all identical twins, was two or three times as great as for ordinary children of the same ages and sex brought up under similar environment. Since environment is a common factor, heredity must explain these results. (3) Twins were discovered to be no more alike in traits in which we are ordinarily given much training, as in addition and multiplication, than

in traits in which we are rarely trained, such as marking A's off a sheet of printed capitals.

III

But there are weaknesses and limitations to both of these interesting studies. Galton's study depended upon a method of verbal report; and Professor Thorndike's tests were measures of special abilities only, rather than of general intelligence, and also, as he states, they did not completely eliminate the possible effects of home and school environment.[1]

With these drawbacks in mind, Professor Merriman set about planning an experimental work on twins which would in great part eliminate these factors. In a very careful and interesting monograph, "The Intellectual Resemblance of Twins," appearing as No. 152 of the *Psychological Monographs*, Professor Merriman reaches this conclusion: "Environment appears to make no significant difference in the amount of twin resemblance."

Other conclusions reached by Professor Merriman are:

(1) That twins suffer no intellectual handicap. This is shown in several ways, the most important of which is the discovery that their mean and median I.Q.'s are practically the same as those of the general population.

(2) That there are two distinct types of twins. Professor Merriman's data show this quite pointedly and in

[1] Consult also Chapter I, p. 7 for general criticism of previous experimental studies of twins.

several ways, the two most important of which are the following:

(1) In every case where like-sex pairs are compared with unlike-sex pairs, the correlation of the like-sex pairs is significantly higher. (2) When sibling data are compared with twin data, the correlations lie much nearer to the unlike-sex pair twin data than to the like-sex pair data. This is in harmony with the biological claim that genetically speaking fraternal twins are siblings.

IV

Several recent experiments on twins all tend to show that "identical twins," meaning by that expression two individuals who essentially duplicate each other mentally and physically, do not exist.

F. Beckerhaus studied twelve pairs of unioval twins who showed marked similarity as to hair, skin color, iris, cornea, and total refraction of eyes, and who exhibited an inherited disposition to the formation of freckles.[1] Yet there were minute but detectable differences in respect to all these qualities.

Dactylograms were very similar but never identical; they were, however, more alike than those of two sides of one individual.

J. Siegel discovered a pair of twins who were very similar in their development and in their mental and temperamental qualities.[2] Likewise they both suffered from a constitutional anomaly in respect to atropin.

[1] "Über einige Zwillinge," *Zeitschrift für Augenkrankheit*, LIX, 264–268.

[2] "Ein Beitrag zur Zwillingspathologie," *Archiv für Kindheit*, vol. LXXVIII, 1926.

"They showed the same complications following infection, but one twin quickly recovered, while her sister died."

E. Strausky has contributed a series of cases in which identical twins have been attacked by the same disease or diseases at the same time, but the progress and outcome of the disease or diseases was different in respect to the individuals of the pair.[1] His conclusion is that identical twins are similar to a high degree, but not exactly alike in respect to their hereditary qualities.

H. L. Koch's measurements of a pair of Siamese twins showed that although they were quite similar, yet in such a test as an association test they gave only eight per cent identical response words.[2]

L. Averill and A. D. Mueller in an extended examination of ten pairs of twins, three of which were identical twins, found that the latter "Cannot be so termed, for it is possible to have fraternal twins that are nearly identical in appearance and yet very dissimilar in many other traits. The correlation is by no means perfect." [3]

Professor H. H. Wilder has investigated for many years the palm- and foot-prints of identical twins. He found that the ridges of the hands and feet of identical twins were more nearly alike than among ordinary brothers and sisters. In many cases the ridges of one twin were mirror images of those of the other. Never-

[1] "Beitrage zur Zwillingspathologie," *Monatsschrift für Kindheit*, vol. XXXI, 1925.

[2] *Journal of Comparative Psychology*, VII (1927), 313–333.

[3] *Pedagogical Seminary* (December, 1925), pp. 612–627.

theless, even in regard to palm- and foot-prints, identical twins were not duplicates.

Very recently Dr. G. P. Crowden reported on twins who, in respect to appearance, differential blood counts, illness, and scholastic and mental characteristics, were very similar; yet the ridges on their finger-prints disclosed marked dissimilarities.[1]

V

Dr. C. E. Lauterbach, in a valuable and extensive study of 212 pairs of twins, was chiefly concerned in the relative contributions of heredity and environment in the causation of similarities and differences in twin pairs.[2] He attacked this general problem by asking:

(1) Do older twins show a greater degree of similarity than younger twins?
(2) Do like-sex pairs of twins show a greater degree of similarity than unlike-sex pairs?
(3) Do twins show a greater degree of similarity in acquired abilities than in original nature?

In addition to this central question of heredity and environment Dr. Lauterbach's study includes the following topics:

(4) Do twins suffer any intellectual handicaps?
(5) Can symmetry reversal in handedness and whorl of head-hair be accepted as evidence of the monozygotic origin of twins?

[1] *Lancet*, CCXII (1927), 300–301.
[2] "Studies in Twin Resemblance," *Genetics*, vol. X, November, 1925.

(6) Do palm patterns offer any certain evidence of the monozygotic origin of twins?

(7) Is there any relationship between left-handedness and twinning?

Dr. Lauterbach's conclusions are:

"(1) Older twins show no greater degree of resemblance than younger twins. This is in conformity with the findings of Thorndike (1905) and Merriman (1924) and favors the argument that heredity is more potent than environment." In another passage concerning this same problem Dr. Lauterbach writes:

> The evidence, though somewhat variable, is, nevertheless, conclusive. Even the averages in each case reveal no greater similarity among the older twins than among the younger twins. . . . An inspection of my data shows that even in traits most subject to training there are no large differences. One might expect greater similarities in reading, arithmetic and writing, abilities subject to training, but such similarities do not materialize except in reading.

"(2) Like-sex pairs of twins show a greater degree of resemblance than unlike-sex pairs. These differences in degree of similarity are attributed by Merriman to the circumstance of origin (uniozygotic or dizygotic). The facts seem to favor the theory."

We quote the following interesting summary statements from Dr. Lauterbach upon the same problem:

> Thus, the evidence all tends in the same general direction. Unlike-sex pairs of twins show a degree of resemblance about equal to that of other sibs, while like-sex pairs show a correlation considerably higher. The degree of resemblance between father and son, based on findings of Elderton (1907)

and others, may be said to be about 40 and that for cousins 25. We have, then, a chain of evidence as follows: [1]

Like-sex twins	80
Unlike-sex twins	50
Other sibs	50
Parent–child	40
Cousins	25

If the one-egg group of like-sex twins could be separated from the two-egg group, we would probably have in the former case a correlation approximating 90; in the latter case, a correlation approximating 50.[2]

The above quotation embraces the third and fourth conclusions of Dr. Lauterbach's study. His further conclusions follow:

"(5) There seems to be no definite tendency among twins toward greater similarity in acquired traits than in native ability. The evidence is somewhat conflicting, a fact noted by Thorndike.

"(6) There is no evidence which warrants the assumption that twins are intellectually handicapped. Merriman also presents data which seem to favor a normal intellectual level in the twin population.

"(7) About twenty per cent of all twin pairs show symmetry reversal in handedness.

"(8) About twenty-five per cent of all twin pairs show symmetry reversal in whorl of the head-hair.

[1] Compare and complement these correlations with those we discovered on *selected* very similar twins, and *selected* very unlike twins. See page 145.

[2] Our own results closely approach Dr. Lauterbach's prediction, although we can affirm neither that all the very like twins were monozygotic in origin nor that all the very unlike twins were dizygotic in origin; but for the purposes of our study the question is irrelevant.

"(9) About thirty-five per cent of all twin pairs show symmetry reversal in handedness or whorl of the head-hair or both.

"(10) Symmetry reversal cannot be accepted as evidence of the monozygotic origin of twins, for the reason that unlike-sex pairs as well as like-sex pairs manifest the phenomenon. Newman and Wilder advance the theory that symmetry reversal is an evidence of the monozygotic origin of human twins. The facts will not substantiate the theory unless the possibility is admitted that monozygotic twins may be of unlike sex.

"(11) Left-handedness is closely associated with twinning. This is evidenced by the large number of twins who are left-handed, by a study of the genealogies of twin-bearing families, and by the circumstance of *situs universus viscerum* among both twins and left-handed individuals.[1]

"(12) It may be that left-handedness and twinning are the result of identical or similar causes. This inference rests on the apparent intimate connection between left-handedness and twinning.

"(13) Palm-patterns afford no certain means of identifying monozygotic twins. *Unlike-sex pairs of twins may show identity of palm-patterns and reveal symmetry reversal.*[2]

We have devoted considerable space to Dr. Lauterbach's study, not solely because of its merit, but also because it has not received the attention it warrants

[1] Our own results further confirm this thesis. See p. 38.

[2] The italics are mine.

and is unknown to many readers who may be interested in the general subject of twins.[1]

VI

In a doctor's thesis presented to the Faculty of the Graduate School of Education of Harvard University in 1928, Mr. Caleb Page collected a large amount of material on twins. Because of limitations of space we may quote but a few of his concluding paragraphs:

The tendency of identical twins to maintain parallelism of growth should in any case indicate what is determined for the individual at birth, and a comparison of the parallelism of growth in identical twin sets with that in fraternal twin sets should indicate the strength of the factor of birth, since both identical and fraternal sets have probably been subjected to equally similar conditions of environment.

An examination of the data for the years 1922 to 1926 of nine identical twin sets measured under the Harvard Growth Study indicates that the birth factor is more powerful on the whole than the factor of environment. The most dissimilar of the nine identical twin sets are more nearly alike, when all differences are combined, than the most similar of the thirteen fraternal sets. . . .

When the nine identical sets of twins are compared with analogous unrelated children in respect to physical and anatomical differences, we have further indication of the powerful influence of the birth factor. But nine fraternal sets of the same show greater differences in length of leg and in measurements which involve length of leg than analogous unrelated children. Weight and anatomic index show like results for fraternal sets.

[1] That part of Dr. Lauterbach's study which is relevant to the present work has been summarized by the author, and the questions and answers numbered by him for the sake of clarity.

Dr. Page's results indicate two general principles: first, that heredity or the "factor of birth" is far more powerful in determining the growth and development of the individual than environmental factors; and second, that there are no identical twins in the sense that at *birth* two individuals are true duplicates of each other.

CHAPTER V

OUR EXPERIMENTAL APPROACH AS RELATING TO HEREDITY AND ENVIRONMENT: METHODS, TESTS, PROBLEMS

I

PREVIOUS investigations of twins, the purpose of which was to obtain some light on the relative importance of heredity and environment, have all proceeded on the basis that it was necessary to obtain as *unselected* a group of twins as possible for the solution of the problem.

On the other hand, we purposely collected our pairs of twins *selectively* on the basis of the following hypotheses:

(1) A comparison of very similar twins of the same sex who live together in a similar environment, with very dissimilar twins of the same sex who live together in a similar environment, would afford an opportunity to measure the potency and persistency of heredity in the determination of intellectual, temperamental, dispositional, and anthropometric traits and forms. Since the individuals of both extreme types of twins lived in similar environments, the greater dissimilarity of the unlike twins of the same sex could not be accounted for by environmental conditions, but solely and exclusively by hereditary factors.

(2) The greater differences, if any, between the members of pairs of very similar twins who live in different environments, and very similar twins who live (together) in a similar environment, are an adequate measure of the possible influence of both physical and social environments. That is, the greater dissimilarity of similar twins living apart in comparison to similar twins living together must be interpreted as caused by environmental factors.

Our first hypothesis states that hereditary tendencies must account for the greater difference found between the members of very dissimilar pairs of twins than is found between very similar twins; our second hypothesis states that environment must account for any greater difference found between similar twins living apart than is found among similar twins who have always lived together.

Thus, after collocating and collating our data we can make the following contrasts:

(1) Contrast the data found on *dissimilar* twins living in *similar* environments with the data found upon *similar* twins living in *similar* environments. The difference discovered must be interpreted as almost wholly due to heredity.

(2) Contrast the data found upon *similar* twins living in *similar* environments (living together) with the data gathered upon *similar* twins living in *dissimilar* environments. Any greater differences discovered among the latter must be largely attributed to environmental causes.

(3) Contrast the data found on *dissimilar* twins living in a *similar* environment with the data gathered on *similar* twins living in *dissimilar* environments. If the latter twins are more alike, despite the fact that they are responding to different environments, while the former type of twins are reacting to a like *milieu*, additional weighty evidence would be adduced in favor of hereditary factors as the chief determinants of mental, temperamental, and anthropometric qualities and measurements.

II

The investigator proceeded somewhat on the basis of the following program, although in many instances some of the detail was omitted.

Age Division of Twins, and Measurements Given to Each Division

Group I. From 4 years to 7 years.

(1) Height, (2) Weight, (3) Head length, head breadth, cephalic index, (4) Hair, eye, skin coloration, (5) Individual and pair photographs, (6) Pintner–Cunningham mental test — *Recess*, — (7) Handwriting specimen, if possible, (8) Drawing ability: picture of girl, man, house, (9) Manual and motor ability, as in paper work, dancing, games, and the like, (10) Disease history, (11) Personal estimates, from teachers, of emotional and temperamental likenesses or differences.

Group II. From 7 years to 10 years.

First six measurements as in Group I.

(7) Otis primary mental test, (8) Handwriting specimens, (9) Drawing ability — *Recess*, — (10) Dearborn A

mental test, (11) Manual and motor ability, (12) Disease history, (13) Personal estimates, from teachers and others, of emotional and temperamental likenesses or differences, interests, talents, sociability, character traits, and the like.

Group III. From 10 years to 18 years ("A" group from 10 to 14, "B" group from 14 to 18).

First six measurements as in Group I.

(7) Dearborn mental test, Form C, (8) Otis arithmetic test, (9) Handwriting specimen, (10) Drawing ability—*Recess*—(11) Manual and motor ability, (12) Disease history, (13) Personal estimates, from teachers, of emotional, temperamental, social, and character likenesses or differences, etc., (14) Otis or Terman mental test.

Group IV. From 18 years upward.

First six measurements as in Group I.

(7) Dearborn mental test, Forms C and D, (8) Otis arithmetic test, (9) Handwriting specimen, (10) Drawing ability—*Recess*—(11) Manual and motor ability, (12) Disease history, (13) Personal estimates, from twins themselves, of their emotional character and interests, likenesses or differences.

III

The following procedure was followed in the selection of the twins:

(1) Identical or similar twins were selected (*a*) on the basis of similarity of appearance, voice, gait, expression, etc.; and (*b*) on the basis of similar school work and general intelligence as judged by the teachers of the twins. Seventeen cases of similar twins on the basis

of the first criterion were not selected by virtue of the second criterion.

(2) Dissimilar twins were selected on a similar twofold basis. Thirteen cases of dissimilar twins were rejected, even though in facial appearance, height, weight, etc., they were very unlike, because mentally, temperamentally, and scholastically they were judged to be "very similar."

Thus similarity of appearance has by no means a +.1 correlation with mental and psychosynergic similarity; also great similarity of appearance is no certain criterion of biological homologous twins. But that there is a high positive correlation or association of traits of resemblance in twins is true; that is, twins who are alike in one or several traits, tend to be alike in general. Fisher's searching analysis of Professor Lauterbach's data on twins demonstrates this. One of his conclusions reads:

> If we set aside twins with large differences in stature as certainly fraternal, the remainder show that those with large differences in cephalic index have on the average larger differences in stature; *mutatis mutandis*, the same is true of cephalic index. The data thus supply, for the first time, evidence of association of resemblance in different traits.

CHAPTER VI

DATA ON DISSIMILAR TWINS LIVING IN SIMILAR ENVIRONMENT

IN THIS chapter the measurements and information obtained from a study of fifty-eight pairs of dissimilar twins, the members of each pair living in the same home and having a similar social, economic, and educational environment are recorded.

Dissimilar twins of the *same* sex only were selected. Their ages range from four years and eight months to eighteen years, and their schooling ranges from kindergarten through the fourth year of high school.

PAIR 1. SEX: MALE. AGE: 9 YEARS, 3 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
G. S.	51½	52	178	143	80	Light	Brown	95
P. S.	49½	55	165	138	84	Brown	Brown	72

G. is *left*-handed. He is in the 4th A grade. G. is talkative, and is not timid. P. is *right*-handed. He is in the 3rd B grade. P. is shy and a bit fearful of strangers.

The twins were also given the Haggerty reading test, Sigma I. Their E.Q.'s in this test were: G., 95; P., 80.

PAIR 2. SEX: FEMALE. AGE: 10 YEARS, 8 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
R. P.	55	71	172	144	84	Black	Gray	98
E. P.	54	56	165	141	85	Brown	Gray	75

[1] Derived from the Dearborn A test.

[2] Derived from the Dearborn A and C tests.

R. is in the 5th grade and is doing excellent school work. She is well balanced and normal in appearance and in gait. R. is *right*-handed.

E. is in a special class. She is dull, and demands constant personal attention in school. She appears a dullard; her gait is noticeably rambling. E. is *left*-handed.

R. is self-conscious, selfish, not good-natured, but a leader in play and games; she has endurance and is well controlled, when not self-conscious. R. is the leader of the two and makes every decision. She is more vain and also more inquisitive than E.

E. is good-natured, but often subject to violent fits of temper over which she has no control. She has enthusiasms which rise and fade more quickly than in her sister. E. has little endurance or perseverance; she is more fearful than R.

Both twins have had measles, mumps, whooping cough, chicken pox, and influenza. E. has also had considerable trouble with tear ducts of both eyes.

PAIR 3. SEX: FEMALE. AGE: 9 YEARS, 9 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
Edith C. ..	53	70	169	148	87	Black	Blue	116
Edna C. ..	52	51	170	145	85	Light	Blue	107

Both children are in the 5th grade, and receive excellent marks. But while Edith is very fond of music and sings very well, Edna has neither taste nor talent for music. Edith is fond of nature and of outdoor sports. Edna shows little liking for either.

[1] Derived from the Dearborn C test and the Otis primary test, form A.

Edith is very light-hearted; she has unusual confidence and poise for a child of her years. She is courageous and resourceful; she is patient, persistent, and has great stick-to-it-iveness.

Edna has little confidence and is overly serious. She is very quiet, thoughtful, and over-sensitive. She is rarely cheerful, being inclined to be sulky. Edna remembers injuries, and is unforgiving.

Both children had a normal birth. From their infancy they have been unlike in almost all important ways, despite the fact that they were given the same environment as far as their native constitutions permitted. In some ways their environment was different, because their constitutions demanded it. For example, Edith was breast-fed for sixteen months, while Edna was breast-fed for a much shorter time. This was because the frailer child needed breast milk.

All of the preceding information was received from teachers, friends, and parents of these two children. While the children were taking the tests the writer jotted down the following notes:

Edna — much quicker in reactions and in comprehension — more nervous and more easily distracted, but better motor coördination — appears annoyed on several occasions. Edith — very appealing — sweet, smiling, more poised, more adaptable socially, a decided extravert, willing and eager.

Both twins had whooping cough when five years of age; both also had measles at this age. Both children had chicken pox when seven years of age. Edna also had scarlet fever when seven. Both have had tonsil and adenoid operations. Edith convalesces much quicker than Edna.

PAIR 4. SEX: FEMALE. AGE: 12 YEARS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
D. W.	59	92	161	140	87	Black	Brown	78
E. W.	61	96	176	151	86	Black	Gray	67

E. is aggressive without being a leader; D. is more of a leader with much less aggressiveness. E. has no control over her temper, has little initiative and few fears, and is playful. D. is self-controlled; she is more serious and self-conscious, and is characterized by loyalty and courageousness. Both subjects are below average in intelligence.

Both children have had measles and whooping cough; E., in addition, has had pneumonia and thyroid trouble.

[1] Derived from the Dearborn A and C tests.

PAIR 5. SEX: FEMALE. AGE: 10 YEARS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
A. S.	58	56	179	142	80	Light	Blue	91
S. S.	57	52	173	143	77	Black	Light blue	83

In appearance these children are very unlike. A. has a slender, Roman nose, S. a thick, hooked nose. A.'s face is round, while her sister's tends to be oval. Their expressions are as typically different as are those of a Hollander and a Spaniard.

A. is more aggressive and decisive; she is the leader of the two. She has no fears, and is courageous in a positive sense. She is reliable, steady, has excellent control of her temper, but has little enthusiasm and is over self-conscious. S. is more playful; she is spoiled and moody. S. is more affectionate than her twin sister, and also more fearful. She too has little enthusiasm, but she is more graceful and agile than A.[2]

A. is in the 5th A grade; S. is in the 4th B grade.

Both children have had measles, at the same time; but A. alone has had scarlet fever, while S. is troubled with kidney disorders.

In the Haggerty reading examination, Sigma I, the E.Q.'s were: A., 90; S., 87.

[1] Derived from the Dearborn A test and the Otis primary test, form A.

[2] From settlement workers.

PAIR 6. SEX: MALE. AGE: 5 YEARS, 4 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
N. A.	40¾	38	177	139	79	Almost black	Gray	80
G. A.	40	39	174	134	77	Light brown	Gray	68

Ever since I have known these twins I have been struck by their temperamental differences. It was immediately evident that G. had a blustering, energetic, "don't care" kind of temperament, and that N. was consumed with fear in every situation which contained any new element. We soon discovered that G. took the world as a joke, and N. took it seriously. For months G. baffled us because no form of punishment we could devise seemed to affect him in any way except to provoke laughter. . . . N. gradually overcame his fears, but remained serious and thoughtful. G. very quickly took part in the group games at school and was interested in the other children; N. was afraid of them and drew away from them, finding his pleasures in playing by himself or in the presence of an adult.

G. will not bother about things and does not care to try so hard for success as N. To G. the world is a place to have a good time in, and nothing else matters much. . . . N. has always been very lovable, and attracts strangers before G. does.

On our records under "control of body" we have G. as fair, but clumsy; and N. as poor, unsteady. Under "control of matter" we have G. "very good"; N. "fair." It is distinctly noted that N.'s use of his hands was more

[1] Derived from the Pintner–Cunningham group test.

awkward than G.'s. Both were affectionate and both showed anger occasionally. The biggest emotional difference was in their fear reactions and their ability to laugh.[1]

PAIR 7. SEX: MALE. AGE: 12 YEARS, 6 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
I. R.	55½	80	178	149	84	Black	Brown	103
S. R.	51¾	71	171	142	83	Brown	Blue	87

This pair of twins is especially interesting, for they have lived in an institution since infancy, and although their environment has been as similar as possible, yet from the beginning the nurses, supervisors, and others have noted marked emotional, temperamental, physical, and intellectual differences. S. is an extravert — quiet, serious, tense, and nervous; he generally carries a smile and laughs at the slightest stimulation. His physical build is less massive, and he is less sturdy than his brother. I. is an extravert, very social; he dominates his brother completely, although not in an offensive manner.

In the Otis advanced group intelligence test the indices of brightness were: I., 102; S., 82.

The following report was obtained from the institution in which the boys live.

[1] This interesting and somewhat detailed contrast was obtained from Miss Abigail A. Eliot, Director of the Ruggles Street Nursery School, Boston, to whom the author is much indebted.

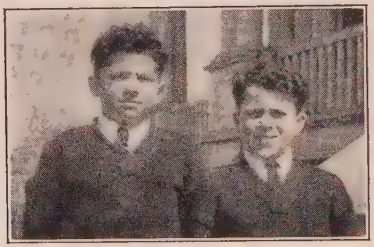
[2] Derived from the Dearborn A test and the Stanford revision of the Binet–Simon test.

TWINS

Isadore Ross

Report by Nurse. This boy possesses boundless energy. He is seldom quiet, and does not care for sports of a solitary nature. Prefers sports in which he may join, and is a natural leader in these sports. He plays fair and square, and is always ready to give the other fellow a chance.

Report by Supervisor. Possesses a good deal of athletic ability and participates in all sports very freely. He exercises willingness in the performing of his duties, so much so that he has the most responsible duty in the dormitory and carries it out to great effect. He is very neat, and not so nervous as his



twin brother. At times he is found with his hands in his mouth, an old habit of his. He is trying to do away with this habit, and is making good success. He is a leader in the sense of getting boys together for sports and other things, and this is a help to his supervisor. Very punctual; does not shirk in anything. Courteous, although a little boisterous occasionally. He always asks permission to do anything; never is found with the boys who have bad habits. He has considerable affection and admiration for his twin brother, more so than for his two older brothers; is found a good deal with his twin brother. He has partaken willingly and effectively in entertainments; is not musically inclined, but likes elocution very much.

Boy is in the 6th grade, average mark "B".

DISSIMILAR TWINS LIVING TOGETHER

Simon Ross

Report by Nurse. Boy is quiet and rather shy. He prefers individual games, but will join in games with the other boys. He will usually follow a leader, but on occasions can be very stubborn. His shyness may be due in part to a defect in speech. He is an affectionate boy, and shows great admiration for his older brothers.

Report by Supervisor. Boy is nervous; puts hands in mouth continuously, more so when asked questions about his misdemeanors; not obstreperous; not a leader, but usually found among the group of boys whose misbehavior is limited to minor offences. Usually found with a smile; always establishing an alibi for his offences, blaming nobody in particular. Neat — occasionally. Shirks a little when given a duty to perform; has never entered into any of the bad doings of some of his companions, due to the admonition of his older brother who is also at the Home and bears this firmly in mind. He was bothered a good deal with enuresis, but a marked improvement has been obtained of late, so much so that it is very infrequent.

Simon is in the 4th grade, average mark "B".

PAIR 8. Sex: Female. Age: 11 Years, 4 Months

	Height	Weight	Hair coloration	Eye coloration	I.Q.[1]
Marie S.	59½	93	Brown	Hazel	127
Maude S.	57	86	Brown	Brown	78

Sitting heights: Marie, 32½; Maude, 30.

Marie is sanguine, self-confident, self-controlled. She has initiative and takes criticism well; she is far more mature in her ideas, and is more thoughtful. Maude is choleric; she lacks self-confidence and self-control, her emotional life is uneven and fitful. She does not take

[1] Derived from the Dearborn C and D tests.

criticism well; she is childish in her thoughts and ideas, is nervous, lacks equilibrium, and is uncertain.

In aptitudes, Marie is "a brilliant, fine student, learns very easily, enjoys reading and study. Maude is a plodder at best, a poor pupil, who does not read much, and who is less mature about what she does read."

The quoted data were obtained from the school where both children have lived since they were seven years of age. They have had the same attentions and advantages in their physical, emotional, intellectual, and spiritual lives, but remain as different as individuals of distinct social classes or natio-races.

Both children have had whooping cough, measles, influenza, and mumps. Maude has had typhoid fever and Marie scarlet fever.

In reading and arithmetic tests the E.Q.'s were: Marie, 121; Maude, 81.

PAIR 9. SEX: FEMALE. AGE: 7 YEARS, 8 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.
S. H.	46½	47½	168	141	84	Golden	Gray	109
B. H.	47¼	46½	172	137	79	Black	Blue	117

[1] Derived from the Pintner–Cunningham and Dearborn A tests.

B. has a keener sense of rhythm, more spirit, and better interpretive ability in esthetic dancing. She is also more graceful, vivacious, sociable, and adaptable. S. is more persevering, more patient, quiet, and mannerly. She is less energetic and aggressive.[1]

In the Haggerty reading test, Sigma I, the E.Q.'s were: S., 112; B., 120.

PAIR 10. SEX: FEMALE. AGE: 17 YEARS, 3 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
E. H.	65½	...	186	153	82	Brown	Brown	116
M. H.	64	...	183	150	82	Black	Gray	105

E.'s hair is curly, while M.'s is straight.

E. dresses very simply; M. wears flashy, smart clothes. E. dances very well, but is not at all athletic; M. does not care for dancing and is like a boy in her athletic tastes and abilities.

E. is sociable, democratic, unassuming. M. is not very sociable, and is proud and haughty. I have known both of them for ten years, and although I have been with them constantly, I have never seen any real similarity between them. E. is very quiet, and is approachable by all. M. talks and struts, and tells everything she knows; she is active, lively, and over-aggressive. E. has the opposite faults, for she is too modest and sedate; yet these qualities win her friends. E. is very much brighter and more studious.

[1] From their teacher of esthetic dancing.

[2] Derived from the Dearborn C and Terman group tests.

PAIR 11. SEX: FEMALE. AGE: 14 YEARS, 10 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
F. P.	64	123	174	147	84	Black	Brown	96
M. P.	62½	110	185	143	77	Brown	Blue	110

F. takes a commercial course, while M. takes a college course in high school. M. has always been more clever and more studious.

F. likes the theater, parties, and fashion. M. is more interested in books, and in the piano.

F. is also more athletic, more energetic, more aggressive than M.

Although they continually disagree and argue, they have a deep affection for each other and rely and depend on each other.[2]

[1] Derived from the Dearborn C and Terman group tests.

[2] From an older friend of theirs.

PAIR 12. SEX: MALE. AGE: 16 YEARS, 4 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
H. L.	63	168	180	151	84	Black	Black	94
M. L.	65½	162	186	152	82	Dark brown	Light brown	102

Both boys have had the same diseases: scarlet fever, diphtheria, measles, chicken pox; and have had the same minor operations, the removal of tonsils and adenoids.

PAIR 13. SEX: MALE. AGE: 7 YEARS, 10 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
C. C.	49	52	178	141	79	Black	Dark blue	101
W. C.	47½	51	171	139	81	Light brown	Light blue	109

W. is in the 3rd A grade; C. is in the 2nd B grade.

In the Haggerty A reading test the E.Q.'s were: W., 110; C., 100.

PAIR 14. SEX: MALE. AGE: 4 YEARS, 8 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[3]
William G.	35½	30	175	140	80	Dark brown	Dark blue	108
Warren G.	38½	34½	168	138	82	Light brown	Light blue	92

William is more headstrong, is physically very much stronger; although at birth the weaker, he walked and talked first, overcoming his inferior physical constitu-

[1] Derived from the Dearborn C and Terman group tests.

[2] Derived from the Dearborn A and Pintner–Cunningham group tests.

[3] Derived from the Pintner–Cunningham group test.

tion, in contrast to his brother, before he was six months old. He is cleverer and more observant, and is quicker in physical movements. William is without fear and is far more troublesome than Warren. He is continually asking questions.

Warren is fearful and timid. He likes picture-books, pictures in papers, and blocks with letters on them. Warren wishes to be with his mother or by himself; William wishes to be with other children. The latter has much better control of his temper.

William has much the better motor control, and is more intimate and companionable with their older brother than with his twin. He is already the leader of a "neighborhood gang." He is more aggressive and outward-looking. He wears shoes two sizes larger than Warren.[1]

Both children have had measles and whooping cough.

PAIR 15. SEX: MALE. AGE: 7 YEARS, 3 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
J. O.	50½	66	194	150	77	Black	Blue	110
F. O.	49½	62	178	151	85	Light brown	Blue	99

J. is a "boss." He is aggressive, pugnacious, forward, and assumes the leadership in everything the boys do. He is musical, playing well on the violin. He likes girls, but with them, as with all others, he is selfish. J. is more intelligent.

[1] From their mother.

[2] Derived from the Dearborn A and Pintner–Cunningham tests.

F. is a much better-natured and more sympathetic boy. He always gives in to his brother. He is more nervous, and is very timid. When he can overcome his timidity F. is more sociable than J. F. is cleverer with his hands, but is less intelligent than J. His control of temper is excellent, and while his twin brother is kind to and interested in his sister, rather than in other little girls,[1] he is interested in other little girls.

In the Haggerty reading test, Sigma I, the E.Q.'s were: J., 134; F., 123.

PAIR 16. SEX: FEMALE. AGE: 9 YEARS, 1 MONTH

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
B. G.....	53	73	165	134	81	Black	Brown	80
R. G.	52	70	168	137	81	Brown	Brown	97

R. is in the 3rd B grade; B. is in the 2nd B grade.

R. is a lively, well-mannered child of even temper and kind disposition. She is coöperative, reliable, and takes criticism well.

B. is ill-tempered, stubborn, jealous, and flighty. She is unforgiving, selfish, and spiteful. She cannot get along well with other children, and is especially hateful to her twin.[3]

In the Haggerty A reading test the E.Q.'s were: R., 98; B., 78.

[1] From their mother.

[2] Derived from the Dearborn A test.

[3] From a settlement worker.

PAIR 17. SEX: FEMALE. AGE: 10 YEARS, 9 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
A. S.	60	79	167	138	83	Brown	Brown	91
G. S.	59	76	176	145	82	Black	Brown	74

These children, oddly enough, although very similar in hair and eye coloration, are very unlike in skin coloration. A. is very fair-skinned, while G. is olive-complexioned.

A. is in the 5th A grade; G. is in the 4th B grade, and is doing very poor school work.

PAIR 18. SEX: MALE. AGE: 13 YEARS, 10 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
H. L.	63	82	170	137	81	Black	Black	77
M. L.	64	87	163	142	87	Black	Black	87

M. is in the 7th grade; H. is in the 5th grade.

PAIR 19. SEX: MALE. AGE: 12 YEARS, 10 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[3]
S. W.	54¾	67½	175	142	80	Black	Blue	89
E. W.	56¼	74½	184	141	77	Brown	Gray	98

S. is much darker in complexion. These boys' voices, laughter, and gait are very noticeably different. The school work of S. is only fair, that of E. is excellent; all of E.'s grades are A's and B's.

As judged by their teachers and friends the boys dif-

[1] Derived from the Dearborn A and C tests.
[2] Derived from the Dearborn C and D tests.
[3] Derived from the Dearborn C test.

fer immensely in ambition, self-control, self-reliance, control of temper, posture, enthusiasm, and imagination, in all of which E. excels; they differ greatly, too, in respect to aggressiveness, coöperativeness, courtesy, self-consciousness, and patience, in all of which S. excels. The twins are considered to be quite alike in courage, humor, motor control, dress, amusements, and food preferences.

PAIR 20. SEX: FEMALE. AGE: 15 YEARS, 1 MONTH

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
F. P.	60¼	108	181	143	79	Black	Brown	85
E. P.	59¼	104	172	142	83	Black	Brown	80

F.'s hair is straight, while E.'s is curly.

F. is more serious and thoughtful. She reads more, and does better work in school. She is one grade higher than E. The twins do not dress alike, and are not congenial; they seldom go together.

E. is a typical flapper: dislikes school and all "work." She likes moving pictures, dancing, and boys. E. is very frivolous and affords an excellent emotional and temperamental contrast to F. Their environment has been similar, but has differed in some respects by virtue of divergent tastes, talents, and desires. The twins differ more in emotion and temperament than in intellect.

[1] Derived from the Dearborn C and Terman group tests.

PAIR 21. SEX: MALE. AGE: 13 YEARS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
O. M.	57	79	189	145	77	Black	Brown	102
F. M.	60	94	180	150	83	Light brown	Green	132

F. has a much lighter complexion. F. is more ambitious, more coöperative, has better self-control, better motor control, better posture, and more enthusiasm than his twin. O. is more social, more of a leader, more aggressive, and has more initiative than F.[2]

F. is in the 8th grade; O. is in the 7th grade.

Both children have had scarlet fever and whooping cough. O. has also had measles and chicken pox.

In the Otis advanced test the indices of brightness were: F., 156; O., 122.

PAIR 22. SEX: MALE. AGE: 12 YEARS, 10 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[3]
Ray. C.	52	67	175	145	83	Black	Brown	82
Rich. C.	53¼	68½	177	142	80	Black	Brown	75

	Raymond	Richmond
Aggressiveness	100[4]	80
Ambition	100	70
Courage	100	95
Courtesy	100	80
Leadership	100	80
Self-control	100	80
Self-consciousness	A little	Marked

[1] Derived from the Dearborn C test.

[2] From their teacher.

[3] Derived from the Dearborn C test.

[4] I am using 100 for the best grade. Raymond is a "B" scholar and Richmond is a low "D".

	Raymond	Richmond
Patience	100	100
Humor	100	75
Control of temper	100	75
Enthusiasm	100	80 (lazy)
Motor control	100	80
Posture	100	100
Walking gait	100	100
Initiative	100	100
Voice	Same pitch, quicker	Same pitch
Reciting	100	75
Woodwork	100	80
Music	100	80 (Does n't like it)
Dress	100	100
Amusements	Gambling	Gambling
Sports	Active	Less active

The twins are always together. The children like Raymond better. Studies preferred are arithmetic, spelling, drawing, geography, and music.

Both children have had measles and mumps.

PAIR 23. SEX: FEMALE. AGE: 10 YEARS, 9 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
E. J.	56	62	181	140	77	Golden	Blue	110
A. J.	54	57	170	139	82	Black	Blue	126

E. wears glasses and has always had trouble with her eyes. A. is *left*-handed, E. *right*-handed. E.'s complexion is much fairer than A.'s.

A. is more aggressive, more courageous, more decisive, and always assumes the leadership where the two children are concerned. E. is more self-conscious, patient, and imaginative. Both children are very courteous

[1] Derived from the Dearborn C and D tests.

and are loyal; they are very loyal to one another. A. has more poise and much more initiative. As an instance of the latter quality, A. starts games or other amusements in which E. participates.

The twins dress alike and have friends in common.[1]

Both twins have had mumps, measles, and whooping cough. E. has also had diphtheria and influenza.

PAIR 24. SEX: FEMALE. AGE: 10 YEARS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
R. M.....	55	69	178	139	78	Black	Blue	133
M. M.	56	84	181	143	78	Light brown	Light blue	112

R. is *right*-handed; M. is *left*-handed.

R. is more aggressive, more courageous, more decisive, and more of a leader than M. She also has better self-control, more initiative and more poise than M.

M. is more self-conscious and more imaginative. The twins have unlike voice-qualities, but I am unable to describe the difference.

[1] From their teachers.

[2] Derived from the Dearborn A and C tests.

The twins dress alike and have the same amusements. R. reads more than M. and they admire different types of juvenile books.[1]

Both children have had diphtheria, whooping cough, measles, and mumps. In addition R. had chicken pox. Both children have had their tonsils and adenoids removed.

PAIR 25. SEX: MALE. AGE: 14 YEARS, 4 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
W. P.	58	94	183	147	80	Brown	Brown	99
G. P.	58½	98	178	149	83	Black	Hazel	117

W. has an uncontrollable temper, and according to his teachers becomes hysterical at the end of an outburst of anger. G. is even-tempered, and has better control of both his moods and his body. He is much more sociable and reliable, but less aggressive.

G., although he lacks aggressiveness, possesses more quality of leadership, through his tact and courtesy, than his twin. He is able to make decisions, is loyal, enters into games well, and is liked by his companions. W. has just the opposite traits. He is stubbornly forward, vacillates, cannot enter into contests and games without flying into fits of rage. G.'s self-control is excellent and his motor control is very good; W. is very poor in both qualities. G., however, is often self-conscious, which interferes with his work and play; W. seems to be totally without self-consciousness. Both

[1] From their teacher.

[2] Derived from the Dearborn C and Terman group tests.

boys have initiative, but W.'s is invariably applied to a wrong or unsocial purpose. The same is true in regard to courage; W. is courageous along wrong lines.[1]

Their laughter is very dissimilar. G. seldom laughs; his laugh is quiet, hardly more than an extended smile. W. laughs frequently and it is the laugh of hysteria.

G. is in the 8th grade; W. is in the 6th.

Both subjects have had measles and whooping cough, and have had their tonsils removed. G. has also had mumps.

In the Otis advanced test the indices of brightness were: W., 98; G., 152.

PAIR 26. SEX: MALE. AGE: 14 YEARS, 7 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
I. C.	71	146	183	144	79	Brown	Brown	104
C. C.	69	131	176	141	80	Black	Blue	79

I. has bright expression, high forehead, and a well-shaped head. C. has a noticeably low forehead, protruding lower lip, and asymmetrical head and face.

I. does good work in the 8th grade, C. poor work in the 7th grade. I. is ambitious, coöperative, courageous, courteous, patient, and has a keen sense of humor. C. lacks all of these traits. I. has a fair posture and carriage; C. is poor in these respects. I. has some initiative, C. none. I. has a little enthusiasm, C. none. I. has fair motor control and does fair woodwork; C.'s movements and coördinations are loose, and he is unable to

[1] From their teachers.

[2] Derived from the Dearborn C test.

work with wood. Neither possesses leadership, and both have a nervous, silly laugh. These evaluations were indorsed by three teachers of this pair.

Both boys have had measles, chicken pox, and mumps. In addition C. has also had double pneumonia.

The Otis group intelligence test was given in addition to the Dearborn C test. In the Otis test the indices of brightness were: I., 99; C., 71.

PAIR 27. SEX: MALE. AGE: 6 YEARS, 9 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
C. A.	46	48	175	144	82	Brown	Gray	83
S. A.	44½	54	173	136	80	Brown	Blue	77

These twins, like so many other dissimilar twins, are not congenial. They do not play together at school. They come to school at different times. They do not help each other in their work, or even in such a small thing as helping to find the other's hat.

S. is more timid than C., and also more self-conscious. Their voices are quite different, C.'s being loud and deep and S.'s finer and higher. Their laughter and smiles are similar. Neither child shows initiative, ambition, or leadership.

PAIR 28. SEX: FEMALE. AGE: 9 YEARS, 3 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
G. S.	57	...	173	142	82	Light	Blue	112
H. S.	52	...	180	146	81	Brown	Hazel	92

[1] Derived from the Dearborn A and Pintner–Cunningham tests.

[2] Derived from the Dearborn A test.

Again the lack of companionship and congeniality between unlike twins. In this case there is even animosity on the part of H. for G. "I am not like G. and don't like her," she remarked. G. is very fond of school and does good work; H. is already "bored" by it. She is proud and disdainful and found the tests "foolish." G. thoroughly enjoyed them and asked when she would be given more; she inquired about their use and meaning. G. is patient, persevering — a "plugger." She does especially good work with her hands, is excellent at drawing, and writes a good hand. In reading and arithmetic she does better work than H., but only because of her greater effort and conscientiousness. H. is the cleverer, and is quick in her mental reactions. But she is impatient and makes no persistent effort. She is poor in her handwork, drawing, and writing.[1]

The twins were also given the Otis primary test. Despite her inferiority of 20 I.Q. points on the Dearborn A test, which largely involves motor intelligence, H. has a superiority of 20 points in the index of brightness scale. The indices of brightness were: G., 88; H., 108.

PAIR 29. SEX: FEMALE. AGE: 15 YEARS, 2 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
A. L.	62	118	180	145	81	Brown	Green	106
K. L.	64½	124	190	154	81	Brown	Hazel	115

[1] From their teachers.

[2] Derived from the Dearborn C and Terman group tests.

K. is better in all of her studies than A. Throughout their school histories this has been the case, despite the fact that their surroundings have been the same.

PAIR 30. SEX: FEMALE. AGE: 16 YEARS, 2 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
Mad. B.	59	110	176	150	85	Black	Brown	97
Mol. B.	60	114	173	148	86	Black	Brown	84

Madeline is in the "high 10th" grade; Mollie is in the "low 9th." Neither child is of high-school caliber as far as intelligence is concerned, but both are persevering and studious.

PAIR 31. SEX: FEMALE. AGE: 8 YEARS, 9 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
Ver. T.	48	48½	174	140	82	Brown	Hazel	94
Var. T.	49	53	177	146	83	Black	Brown	77

The teeth of these twins are strikingly unlike in size, formation, coloring, and spacing. It was from the immediate contrast in their teeth that this pair was selected as a case of extreme dissimilarity.

The twins were also given the Otis primary test. The indices of brightness were: Ver., 94; Var., 77.

PAIR 32. SEX: FEMALE. AGE: 13 YEARS, 9 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[3]
Emily P.	53	62	175	137	78	Golden	Hazel	85
Edith P.	55¾	76	186	140	75	Almost black	Brown	96

[1] Derived from the Dearborn C and Terman group tests.
[2] Derived from the Dearborn A test.
[3] Derived from the Dearborn C and Terman group tests.

Emily is far lighter in complexion. This is a case of very dissimilar twins who are nevertheless extremely congenial. Emily is very dependent upon her more robust twin. She is timid, shy, and most reserved. Edith is confident, aggressive, buoyant, alert. She was talkative and inquisitive concerning the tests.

In school work Edith is much more advanced. She is doing "A" work in the 8th grade, while Emily is doing "C" work in the 7th. She rightly belongs in the 6th grade, but through sentiment and sympathy she had been placed in the 7th. Of all their studies Emily prefers arithmetic, Edith grammar. In writing and in sewing, however, Emily excels Edith.[1]

Both children have had measles; Emily also has had whooping cough and mumps.

PAIR 33. SEX: FEMALE. AGE: 7 YEARS, 2 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
M. M.	44½	40½	166	140	84	Golden	Light blue	99
J. M.	47	49	175	146	83	Dark brown	Dark blue	110

J. is forever laughing and smiling. She is more alert, more aggressive, and far less timid. M. is a shy and more serious child. She seems to make greater efforts than J.[3]

[1] We have often found that children who are mentally inferior are above average in sensory-motor-mechanical functions.

[2] Derived from the Dearborn A and Pintner–Cunningham tests.

[3] From their teacher.

PAIR 34. SEX: FEMALE. AGE: 10 YEARS, 10 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
C. T.	54	65	179	141	79	Dark brown	Brown	80
M. T.	52	71	178	138	78	Light brown	Gray	75

C. is aggressive; she does her handwork well and does good work in arithmetic. She is more modest than M.; although they are both somewhat backward for their age, C. is less so.

M. is forward in her manners and awkward in her motions, and is much below normal in mentality. Two years ago her I.Q. rating was 72.

C. is in the 4th grade and M. in the 3rd. C. does her best school work in arithmetic; her chief out-of-school interest is dancing, which she does skillfully. M. cannot dance; her movements are uncoördinated and she is very self-conscious of the fact.

PAIR 35. SEX: FEMALE. AGE: 9 YEARS, 8 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
S. G.	47½	48½	165	134	81	Light brown	Brown	80
G. G.	48	45	161	131	81	Dark brown	Black	74

S. has a long face, while G.'s is square-shaped. This is the most obvious difference in physical characteristics between the twins.

[1] Derived from the Dearborn A test.
[2] Derived from the Dearborn A test.

The twins were also given the Otis primary test. The indices of brightness in this test were: S., 86; G., 50. The nearest I.Q. equivalents were: S., 88; G., 60.

PAIR 36. SEX: MALE. AGE: 8 YEARS, 7 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
J. R.	53	59½	169	145	86	Black	Brown	78
P. R.	52	58	164	142	87	Black	Brown	87

P. is in the 3rd grade; J. is in the 2nd grade.

The twins were also given the Otis primary test. The indices of brightness were: J., 62; P., 76. The nearest I.Q. equivalents were: J., 84; P., 90.

PAIR 37. SEX: FEMALE. AGE: 11 YEARS, 4 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
C. T.	58	80	187	144	77	Brown	Blue	78
E. T.	53	61	175	147	84	Brown	Blue	96

C. is in the 4th grade; E. is in the 5th grade.

PAIR 38. SEX: FEMALE. AGE: 8 YEARS, 6 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[3]
J. W.	52¾	61	170	154	91	Dark brown	Brown	84
H. W.	59	74	171	148	87	Light brown	Gray	95

H. is three years older emotionally and socially, and leads and directs her twin sister in all activities.

[1] Derived from the Dearborn A test.
[2] Derived from the Dearborn C test.
[3] Derived from the Dearborn A test.

PAIR 39. SEX: MALE. AGE: 11 YEARS, 11 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
J. L.	54¼	60¼	176	137	79	Brown	Gray	95
D. L.	56¼	78	179	139	80	Golden	Blue	108

The smaller twin, J., is the leader in every way, except intellectually. Both boys are difficult to manage, are up to all sorts of tricks, and must have their fun at all hours. D. is in the 7th A grade, and is doing better work than J., who is in the 6th B.

The twins were also given the Otis advanced group test. The indices of brightness in this test were: J., 79; D., 109.

PAIR 40. SEX: FEMALE. AGE: 9 YEARS, 7 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
A. D.	45	45½	173	142	82	Black	Brown	73
J. D.	46	49	176	141	81	Black	Black	90

A.'s face is long and narrow, J.'s rounder and fuller. A. has some defect in her eyes; J.'s eyes are large and beautiful. A.'s body and limbs are poorly developed; she is awkward, anemic, and sickly. J. is well developed, lithesome, and energetic. She is very graceful in her gait and in her actions.

A. is conscientious, persevering, attentive, and very self-conscious. She takes her cue from her twin sister in everything.

J. is vivacious, forward, carefree, and sometimes careless in her work. Everything comes easy to her. She is

[1] Derived from the Dearborn C test.

[2] Derived from the Dearborn A test.

musical, carrying tunes excellently; she dances well, having a sense of rhythm. J. is playful, full of fun, and intelligent, but neither conscientious nor persevering. She takes her leadership as a matter of course, not only with her sister but with her other playmates.[1]

In twelve silent reading tests J. and A. received the following grades:

J. — Six A's, four B+'s, one B, one C.

A. — Three A's, no B+, three B's, two C's, two D's, two E's.

Strange to say, J. has had much more sickness than A. Both have had measles. J. has also had mumps and whooping cough.

The twins were also given the Otis primary test. The indices of brightness were: A., 66; J., 82.[2]

PAIR 41. SEX: FEMALE. AGE: 11 YEARS, 4 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[3]
K. B.	56	65	181	141	78	Black	Brown	87
R. B.	53¼	61	178	138	77	Brown	Blue	68

K. is sweet, generous — a lovable child. She is poised, and prepossessing in her appearance. She is even-tempered, reliable, and steady.

R. is silly and boisterous; she lacks poise, is undependable, and irregular in her work. She bursts out into laughter frequently, and with little or no ground for it.

[1] From two teachers.

[2] Derived from the Dearborn A test.

[3] Derived from the Dearborn C test.

K. is dark-complexioned; R. is very fair in skin coloration.

R. is in the 4th grade; K. is in the 6th grade.

The twins were also given the Otis advanced test. The indices of brightness were: K., 94; R., 59.

PAIR 42. SEX: FEMALE. AGE: 11 YEARS, 11 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
J. S.	56½	70½	180	146	81	Golden	Blue	85
A. S.	54½	61	178	138	78	Dark brown	Hazel	103

J. has very large eyes, and a large, prominent nose. A.'s eyes are much smaller, and her nose is delicately shaped, high, and slender.

J. is stolid, phlegmatic, without social tact, and lacking in a sense of humor. A. is imaginative, humorous, playful, and dainty. She has personal charm and sweetness.[2]

A. is in the 6th grade; J. is in the 5th grade, and is doing poorer work there than A. is accomplishing in the higher grade.

PAIR 43. SEX: FEMALE. AGE: 11 YEARS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[3]
L. R.	53½	75	175	150	86	Brown	Brown	83
R. R.	55½	82	179	152	85	Brown	Brown	76

Although the coloration of this pair of twins is similar, R.'s eyes are much larger, and her hair is curly, while that of her sister is straight.

[1] Derived from the Dearborn C test.

[2] From two teachers.

[3] Derived from the Dearborn C test.

L. is ambitious without having much aggressiveness; R. is aggressive to the point of intruding upon every conversation or gathering, without having any ambition. L. is coöperative, courteous, obedient, and has a sense of fair play; R. refuses to work in conjunction with anyone; she is impudent, without discipline, and has no sense of another's rights. L., however, is more self-conscious and is timid; R. has no fears and is often foolishly rash; L. has excellent control of her temper, while R. breaks into furious tantrums whenever she is thwarted. Neither child has any sense of humor, and both are without leadership qualities.[1]

In the Otis primary test, the indices of brightness were: L., 70; R., 60.

PAIR 44. SEX: FEMALE. AGE: 10 YEARS, 1 MONTH

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
R. P.	51	59	163	128	79	Brown	Brown	97
G. P.	53	59	160	133	83	Black	Hazel	87

R. has light complexion, G.'s is much darker. R. is more ambitious, patient, persevering, and coöperative than G. R. is less timid, more aggressive, with a better sense of humor. Neither child displays any leadership or unusual traits. Both children are courteous and neat.[3]

[1] From three of their teachers.

[2] Derived from the Otis primary test.

[3] From their principal.

PAIR 45. SEX: FEMALE. AGE: 10 YEARS, 6 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
G. P.	50½	55	181	141	78	Black	Brown	89
P. P.	49	51	183	139	76	Brown	Black	80

P. wears glasses; she has had eye trouble since birth. G. has never had trouble with her eyes, and sees well without glasses. P. is *left*-handed, G. *right*-handed.

PAIR 46. SEX: MALE. AGE: 14 YEARS, 8 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
Harold H. .	62	108	182	153	84	Light brown	Blue	98
Herbert H.	67¾	113	181	152	84	Black	Brown	112

The I.Q.'s in the Dearborn test were: Harold, 102; Herbert, 116. The I.Q.'s in the Terman group test were: Harold, 94; Herbert, 108.

PAIR 47. SEX: MALE. AGE: 16 YEARS, 1 MONTH

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[3]
R. M.	62½	119	195	146	75	Red	Brown	91
G. M.	69	133	183	145	79	Black	Blue	82

R. is doing "fair" work in the 8th grade; G. is barely getting along in the 6th grade and according to his teacher would be far better off doing routine mechanical work. R. wants to go through high school, but his mentality hardly seems to be sufficient to warrant such an effort.

[1] Derived from the Dearborn A test.
[2] Derived from the Dearborn C and Terman group tests.
[3] Derived from the Dearborn C test.

PAIR 48. SEX: MALE. AGE: 15 YEARS, 5 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
H. K.	58	84	177	146	82	Black	Brown	96
R. K.	59	85½	172	152	89	Light brown	Brown	90

The I.Q.'s in the Dearborn C test were: H., 98; R., 96. The I.Q.'s in the Terman group test were: H., 94; R., 84.

PAIR 49. SEX: MALE. AGE: 8 YEARS, 8 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
G. N.	52¼	60¼	176	149	85	Brown	Hazel	127
J. N.	51	55¼	170	148	87	Brown	Hazel	111

The most interesting contrast between these twins is the great superiority of G. over J. on the Dearborn test, and the superiority of J. over G. on the Otis primary test.

The indices of brightness in the Otis primary test were: G., 115; J., 128.

PAIR 50. SEX: FEMALE. AGE: 13 YEARS, 2 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[3]
Ethel B....	59	...	180	150	83	Brown	Blue	92
Esther B...	61¼	...	189	157	83	Brown	Gray	108

Sitting heights: Ethel, 29¾; Esther, 31¼.

Ethel has a round face; Esther has a long face.

Ethel has had measles, whooping cough, and constant eye trouble. She wears glasses. Esther has also

[1] Derived from the Dearborn C and Terman group tests.

[2] Derived from the Dearborn A test.

[3] Derived from the Dearborn C and Terman group tests.

had measles and whooping cough; she does not wear glasses and has never had trouble with her eyes.

The I.Q.'s in the Dearborn C test were: Ethel, 85; Esther, 109. The I.Q.'s in the Terman group test were: Ethel, 99; Esther, 107.

PAIR 51. SEX: FEMALE. AGE: 8 YEARS, 1 MONTH

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
F. S.	48½	48	170	139	82	Black	Brown	122
V. S.	49¾	50	171	138	81	Light brown	Brown	96

Sitting heights: F., 24¼; V., 25.

The twins are very dissimilar in disposition, according to their mother. F. is cleverer, more aggressive, and has more energy, play-spirit, and initiative. She has also better control of her temper, and better motor control. V. is more affectionate, more friendly, and more grateful; she tries harder to do her school work, is more timid and self-conscious than F.

F. is in the 3rd grade; V. is in the 2nd grade.

In the Haggerty I reading test the E.Q.'s were: F., 110; V., 91.

PAIR 52. SEX: MALE. AGE: 15 YEARS, 4 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
Elmer B.	64	113	196	142	72	Dark auburn	Black	101
Edwin B.	66	133	191	146	76	Light auburn	Brown	83

[1] Derived from the Dearborn A test.

[2] Derived from the Otis advanced test.

The twins have always been unlike. "Edwin is more energetic, aggressive, and assertive; Elmer more self-conscious and shy. Neither boy has much initiative, perseverance, or enthusiasm." [1]

Both boys have had mumps. Elmer has had infantile paralysis; Edwin has had diphtheria and measles.

The "following directions" test of the Otis group test was given them. Edwin made 13 out of 20 possible points, or 65 per cent; Elmer made 11 points, or 55 per cent.

PAIR 53. SEX: MALE. AGE: 14 YEARS, 7 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
Frank C. . .	65	111	181	153	85	Black	Brown	105
Fred C. . . .	64	107	183	155	85	Black	Gray	118

The I.Q.'s in the Dearborn C test were: Frank, 103; Fred, 119. The I.Q.'s in the Terman test were: Frank, 107; Fred, 117. Frank is *left*-handed; Fred is *right*-handed.

PAIR 54. SEX: MALE. AGE: 6 YEARS, 8 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[3]
Alando T. .	46	54	177	140	80	Black	Black	75
Amando T.	45	51	186	146	78	Black	Black	83

[1] From their teachers.

[2] Derived from the Dearborn C and Terman group tests.

[3] Derived from the Dearborn A and Pintner–Cunningham tests.

PAIR 55. SEX: FEMALE. AGE: 18 YEARS, 1 MONTH

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
B. C.	64½	119	190	135	71	Black	Brown	88½
A. C.	65¾	123	192	136	71	Black	Gray	98½

The I.Q.'s in the Dearborn test were: B., 86; A., 100. The I.Q.'s in the Terman test were: B., 91; A., 97.

PAIR 56. SEX: MALE. AGE: 12 YEARS, 5 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
L. S.	55¼	...	184	141	77	Brown	Gray	93
D. S.	54¼	...	183	143	78	Brown	Gray	79

L. is in the 6th A grade; D is in the 5th B grade. L. is more aggressive and forward; he has also more curiosity; he is more ambitious, assertive, and masculine. D. is quiet, timid, and more self-conscious; he tries to do the things his brother does, both intellectually and physically, but cannot keep abreast of him.

PAIR 57. SEX: MALE. AGE: 10 YEARS, 9 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[3]
C. G.	53¼	66	180	146	81	Yellow	Hazel	108
G. G.	54	70	182	147	81	Yellow	Hazel	121

C. is *left*-handed; G. is *right*-handed. They both have very light complexions.

Both twins have had measles and whooping cough.

[1] Derived from the Dearborn C and Terman group tests.
[2] Derived from the Dearborn C test.
[3] Derived from the Dearborn C test.

The twins were also given the Otis advanced test. The indices of brightness in this test were: C., 129; G., 148.

PAIR 58. SEX: MALE. AGE: 11 YEARS, 11 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
J. C.	63	107	182	146	80	Black	Brown	101
B. C.	64	114	177	146	83	Brown	Gray	92

The twins were also given the Otis group intelligence test. The indices of brightness were: J., 103; B., 76.

[1] Derived from the Dearborn C test.

CHAPTER VII

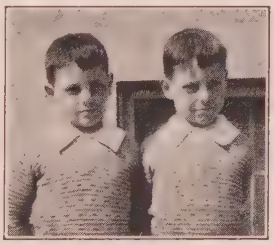
DATA ON SIMILAR TWINS LIVING IN SIMILAR ENVIRONMENT

IN THIS chapter the measurements and information derived from a study of thirty-eight pairs of similar twins, the members of each pair living in the same home with similar social, economic, and educational background, are recorded.

The ages of the twins range from five years and two months to eighteen years, eleven months, and their school status ranges from the kindergarten to the last year of high school.

PAIR 1. SEX: MALE. AGE: 6 YEARS, 9 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
R. G.	46	47¾	176	134	76	Black	Brown	119
L. G.	46½	48¾	177	135	76	Black	Brown	115



[1] Derived from the Pintner–Cunningham test.

Sitting heights: R., $25\frac{1}{2}$; L., $25\frac{3}{4}$.

R. is *right*-handed; L., is *left*-handed.

The twins were also given the Otis primary test. The indices of brightness were: R., 126; L., 110.

PAIR 2. SEX: FEMALE. AGE: 11 YEARS, 1 MONTH

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
N. Z.	55	$64\frac{1}{2}$	179	138	77	Dark brown	Gray	113
F. Z.	$55\frac{1}{2}$	$68\frac{1}{2}$	175	140	80	Dark brown	Gray	113

Both children are in the 6th grade and their grades in *all* subjects were always approximately the same. N. is *right*-handed; F. is *left*-handed.

Both children have had measles and chicken pox. The same teeth have been extracted in both mouths, and the same teeth have been filled.

The twins were also given the Otis advanced test. The indices of brightness were: N., 132; F., 133. The I.Q. equivalents were N., 111; F., 111.

PAIR 3. SEX: FEMALE. AGE: 11 YEARS, 2 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
Ber. S.	56	$91\frac{1}{2}$	170	143	84	Light brown	Blue	92
Bea. S.	$56\frac{1}{4}$	$94\frac{1}{2}$	170	146	86	Light brown	Blue	91

[1] Derived from the Dearborn C and Terman group tests.

[2] Derived from the Dearborn C test.

Both children are in the 6th grade, like the same subjects, and get practically the same grades. Bertha is *right*-handed; Beatrice is *left*-handed.

The twins were also given the Otis advanced test. The indices of brightness were: Bertha, 109; Beatrice, 111. The I.Q. equivalents were: Bertha, 103; Beatrice, 104.

PAIR 4. SEX: FEMALE. AGE: 6 YEARS, 9 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloraton	Eye coloration	I.Q.[1]
D. P.	43	42	164	136	83	Brown	Brown	99
J. P.	42½	41	165	137	83	Brown	Brown	102

Both children are in the 1st grade. D. is *right*-handed; J. is *left*-handed. They are equally poor in motor control, handle their pencils very awkwardly, and walk stooped and slouchily. They are poorly nourished children, but have responded very well since attending a Settlement House. They are affectionate, and grateful, but very timid.[2]

[1] Derived from the Pintner–Cunningham mental test.

[2] From a settlement worker.

PAIR 5. SEX: MALE. AGE: 8 YEARS, 1 MONTH

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
R. C.	49½	57½	179	141	79	Light	Blue	84
B. C.	50	58½	177	145	82	Light	Blue	83

Both boys are in the 2nd grade; both had to take the 1st grade twice.

The twins were also given the Otis primary test. The indices of brightness were: R., 72; B., 76. The I.Q. equivalents were: R., 88; B., 90.

PAIR 6. SEX: MALE. AGE: 15 YEARS, 8 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
P. L.	61¾	...	188	151	83	Black	Black	103
A. L.	61	...	184	154	84	Black	Black	102

Both boys are in the second year of high school. In order to keep them from depending upon each other, and in order to develop individuality in each, the boys have been to different high schools. P. goes to an English high school; A. attends a commercial high school. They stated that they felt no less alike than two years previously.

PAIR 7. SEX: MALE. AGE: 13 YEARS, 3 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[3]
R. F.	57	...	180	154	86	Brown	Blue	91
M. F.	57	...	180	153	86	Brown	Blue	95

[1] Derived from the Dearborn A test.

[2] Derived from the Dearborn C and Terman group tests.

[3] Derived from the Dearborn C and Terman group tests.

Both twins have fair complexions. Each was born with a scar on his head.

They have had the same diseases: mumps, diphtheria, measles, swollen glands; both have also had their tonsils and adenoids removed.

The I.Q.'s in the Dearborn C test were: R., 88; M., 93. The I.Q.'s in the Terman test were: R., 94; M., 97.

PAIR 8. SEX: FEMALE. AGE: 5 YEARS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
M. B.	46	51	166	141	85	Dark brown	Brown	97
L. B.	46	50½	166	141	85	Dark brown	Brown	97

Their own mother cannot tell these twins apart until they speak; their voices alone are dissimilar.

Both children have the same disease history: chicken pox, measles, and removal of tonsils. Both have had ear trouble.

PAIR 9. SEX: FEMALE. AGE: 14 YEARS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
S. G.	63¼	...	186	143	77	Brown	Brown	107½
R. G.	62¾	...	186	143	77	Brown	Brown	106

Sitting heights: S., 31⅝; R., 31½.

The twins are in the second year of high school. Their studies and their grades have been and are very similar. Their tastes in extra-academic fields are very much alike.

[1] Derived from the Pintner–Cunningham mental test.

[2] Derived from the Dearborn C and Terman group tests.

Both children have had measles, and S. has also had pneumonia. The twins have always been unusually susceptible to colds. R. is the weaker physically; her recuperative power after a severe cold is less than S.'s.

The I.Q.'s of the twins in the Dearborn C test were: S., 108; R., 104. In the Terman test they were: S., 107; R., 108.

PAIR 10. SEX: MALE. AGE: 12 YEARS, 7 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
P. F.	59½	...	185	145	78	Brown	Gray	105
M. F.	58¼	...	185	146	79	Brown	Gray	109

Both children have had scarlet fever, diphtheria, and measles. M. has also had mumps. Both boys wear glasses, the result of the same defect. P. is stronger physically.

The I.Q.'s in the Dearborn C test were: P., 106; M., 106. The I.Q.'s in the Terman test were: P., 104; M., 112.

PAIR 11. SEX: FEMALE. AGE: 6 YEARS, 1 MONTH

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
D. M.	44¼	40	176	143	81	Dark brown	Blue	65
A. M.	44¼	39½	176	141	80	Dark brown	Blue	68

Sitting heights: each 23¼.

The M. twins resemble each other closely in play spirit, temper, motor control, grace, and sense of grati-

[1] Derived from the Dearborn C and Terman group tests.

[2] Derived from the Pintner–Cunningham mental test.

tude. D. is slightly more aggressive and self-conscious. A. has more physical strength, and is more patient and somewhat more timid.[1]

PAIR 12. SEX: FEMALE. AGE: 5 YEARS, 4 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
V. S.	42¼	36½	165	132	82	Brown	Blue	81
D. S.	42	37½	166	132	81	Brown	Blue	81

Sitting heights: each 22¾.

The twins like the same things to play with; they like the same things to eat; they like the same children, and their dislike of playmates is usually the same. V. is a bit more aggressive than D., but neither is subservient to the other.[3]

Both children have had scarlet fever, diphtheria, and measles; D. has also had whooping cough.

PAIR 13. SEX: FEMALE. AGE: 6 YEARS, 1 MONTH

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[4]
Alice K. ...	45¼	43½	165	135	82	Black	Brown	100
Agnes K. ..	45½	45½	166	137	83	Black	Brown	104

Sitting heights: each 24¾.

Both children are in the 1st grade. Alice is *right*-handed; Agnes is *left*-handed.

Alice and Agnes are equally self-conscious; neither

[1] From the director of the settlement where the twins attend four times weekly.

[2] Derived from the Pintner–Cunningham mental test.

[3] From a settlement worker.

[4] Derived from the Dearborn A test.

displays any timidity. Both lack grace and poise. The motor control of both is poor.[1]

In the Haggerty I reading test both secured E.Q.'s of 85.

PAIR 14. SEX: MALE. AGE: 12 YEARS, 3 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
Walt. M. . .	57¼	75	170	141	83	Light brown	Blue	84
Will. M. . . .	57	73	170	144	85	Light brown	Blue	78

Both boys are in the 6th grade. Walter does slightly better school work than William.

William is *right*-handed; Walter is *left*-handed in most things. He has been trained to use his right hand in writing and in some other things. He is also *left-footed.*

The twins were given the Otis advanced test. The indices of brightness were: Walter, 74; William, 79.

PAIR 15. SEX: MALE. AGE: 14 YEARS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[3]
T. M.	57¼	94¼	184	147	80	Brown	Hazel	75
J. M.	57	89¼	184	146	79	Brown	Hazel	74

Both twins are right-*handed* but J. is left-*footed* (in football). The boys dislike music, but are very good in manual training. Both won medals in running in a city track meet.

[1] From a settlement worker.

[2] Derived from the Dearborn C test.

[3] Derived from the Dearborn C and Terman group tests.

The gaits, voices, smiles, and laughter of these twins are very similar. T. met one of J.'s friends, who spent a whole day with T., the friend not knowing that he was with T. instead of J.

Three teachers, several playmates, and the parents of these boys were questioned about them on many traits and qualities. The following is a balanced summary of their opinions: the twins are equal in aggressiveness, amount of ambition, spirit of coöperation, courage, courtesy, leadership, self-control, self-reliance, sense of humor, control of temper, motor control, posture, voice, gait, enthusiasm, imagination, musical ability (none); and have very similar tastes in dress, amusements, sports, books, foods, and athletics. T. is slightly more self-conscious than J.; the latter is more persevering, patient, and poised than T. Both boys were considered to be "rather dull" in any school work other than manual. They are in the 7th C grade.

Both children have had measles, mumps, scarlet fever, and whooping cough.

The twins were also given the Otis advanced test. The indices of brightness were: T., 79; J., 73.

PAIR 16. SEX: MALE. AGE: 11 YEARS, 1 MONTH

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
Ham. S.	52¾	68½	183	143	80	Brown	Hazel	109
How. S.	52¼	72¼	184	145	80	Brown	Hazel	108

The boys are in the 5th grade.

Several teachers and playmates were questioned

[1] Derived from the Dearborn C and Terman group tests.

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about this pair of twins on many traits and qualities. The following is a balanced summary of their opinions. The twins are equal in, or are very similar in respect to, aggressiveness, ambition, coöperation, courtesy, perseverance, play spirit, patience, humor, control of temper, motor control, posture, voice, imagination, gait, musical ability; and are very similar in such tastes as dress, amusements, sports, books, foods. Hammond has more courage, more leadership ability, more self-reliance, and more poise than Howard; the latter has more self-control, is more self-conscious and has more enthusiasm than Hammond. This pair of twins is regarded as being somewhat less alike than pair 15 (they had teachers and friends in common).

They were also given the Otis advanced test. The indices of brightness were: Hammond, 107; Howard, 97.

PAIR 17. SEX: FEMALE. AGE: 9 YEARS, 11 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
Mur. M.	51¾	60	179	137	77	Brown	Brown	97
Mer. M.	52½	64	179	138	77	Brown	Brown	99

Both children are in the 4th grade.

"The esthetic side of their natures will never be so well developed as the practical side. They don't care for drawing, music, or poetry. At home they prefer household duties to books, and they are more efficient in housework than school work. They both sew neatly, and equally well.

[1] Derived from the Dearborn C test.

"Although they are full of fun, they are very apt to play quietly and almost always by themselves rather than with other children. I have noticed that they will not play games which are contests in which one might beat the other. They find some amusing thing to do together. The twins are both fond of animals, which receive all the interest and attention that other little girls give to dolls.

"In their habits they are very much alike. They sit and stand, walk and talk, alike. In a spelling match they always stand together, both with their hands clasped in front, in exactly the same attitude.

"The twins are terribly necessary and sufficient to each other. They rely absolutely on each other, and I have never known one to fail the other in any way. Sometimes it seems as if they were one, not two. They come up the road in perfect step, absolutely satisfied in being together. They are equally delighted over any victory or honor that one of them wins. Nothing is 'mine,' everything 'ours.' The twins wrote stories for me in class several days ago, with no possible chance of comparing papers. One first sentence is: 'Last night I went *over* the store for a lady and brought the dog.' The other story starts: 'A lady asked me to go *over* the store for her and we took the dog.'" [1]

They were also given the Otis primary test. The indices of brightness were: Muriel, 102; Meredith, 104.

[1] From their teacher, in conjunction with their mother.

PAIR 18. SEX: FEMALE. AGE: 11 YEARS, 11 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
B. W.	63	102	188	140	74	Brown	Brown	138
E. W.	64½	108	189	141	74	Brown	Brown	137

B. is *left*-handed; E. is *right*-handed. The twins look extremely alike. Their chief difference is due to a local injury in B.'s left leg (which makes her an inch and one half shorter). Their complexions, teeth, and noses are very much alike.

They like the same sort of persons; their children friends and teacher friends are the same.

The twins are good in the same studies, and like the same books. They smile, laugh, and point in the same way. They even walk similarly, despite B.'s lameness. They both play the violin, and are equally good in sewing and cooking.

They told me, entirely spontaneously, that "we love each other more than anyone else in the world."

When sitting down they are very often mistaken for one another. They are in the same grade, and were thought equally unusual in intelligence by their teachers.

The twins were also given the Otis advanced test. The indices of brightness were: B., 173; E., 170.

[1] Derived from the Dearborn C test.

PAIR 19. SEX: FEMALE. AGE: 7 YEARS, 11 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
H. T.	50	...	170	136	80	Golden	Blue	82
R. T.	50	...	170	136	80	Golden	Blue	89

Both children were in the 1st grade twice.

Both children have had chicken pox and whooping cough. Their first vaccination took in each case.

The twins were also given the Otis primary test. The indices of brightness were: H., 70; R., 76. The I.Q. equivalents were: H., 76; R., 80.

PAIR 20. SEX: MALE. AGE: 7 YEARS, 9 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
Clyde S. ..	52½	...	175	149	85	Dark brown	Brown	95
Clar. S. ...	52½	...	176	147	83	Dark brown	Brown	90

Both children failed the first time in the 1st grade, in which they were at the time of the tests.

The first vaccination of both boys did not take; the second one took in each case.

They were also given the Otis primary test. The indices of brightness were: Clyde, 92; Clarence, 84. The I.Q. equivalents were: Clyde, 94; Clarence, 88.

[1] Derived from the Dearborn A test.

[2] Derived from the Pintner-Cunningham and Dearborn A tests.

PAIR 21. SEX: FEMALE. AGE: 12 YEARS, 9 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
S. D.	62½	143	194	160	82	Black	Blue	118
A. D.	62	132	190	157	83	Black	Blue	111

The twins are in the 7th grade. S. is *left*-handed; A. is *right*-handed.

The twins' voices and laughter are very similar.

"Both these girls take an active interest in school work, doing equally well; they are coöperative at all times. They are both courteous, and are especially considerate and loyal in their relations to each other. They have excellent self-control and are not self-conscious. They are so much alike in these traits and in many others that the teachers who just saw them passing singly in the halls, did not know for several weeks that there were two of them, since they act, and carry themselves so much alike. Their voices are identical and so too is their manner of expression. They both enjoy the same amusements, are always dressed alike, and seem to have a common mind."[2]

Both children have had chicken pox, measles, and whooping cough. S., the heavier twin, has also had pneumonia and diphtheria.

They were also given the Otis advanced test. The indices of brightness were: S., 138; A., 123. The I.Q. equivalents were: S., 113; A., 108.

[1] Derived from Dearborn C and Terman group tests.

[2] From their teacher.

PAIR 22. SEX: MALE. AGE: 11 YEARS, 4 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
H. H.	54	64	188	140	74	Light brown	Blue	109
W. H.	53½	63	188	141	74	Light brown	Blue	108

The twins are in the 6th grade. Both have very black eyebrows, that contrast strikingly with their light-brown hair.

Both twins have had mumps and whooping cough, and both have had their tonsils and adenoids removed.

The indices of brightness were: H., 126; W., 123.

PAIR 23. SEX: FEMALE. AGE: 10 YEARS, 2 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
T. M.	49	54	186	141	76	Brown	Green	114
V. M.	50	58	187	142	76	Brown	Green	114

Both twins are *right*-handed, and the complexion of both is very fair.

T. and V. are equally ambitious and persevering.

[1] Derived from the Otis advanced test.

[2] Derived from the Dearborn C test.

Both are careful and painstaking in their work. Neither is aggressive; both show good self-control, and are always ready to coöperate with others. They are courteous, patient, and very loyal to each other.

Their voices are identical. Both are bright and quick to see a joke. Their choice of colors in dress, of books, amusements, games, and friends is always the same. They manifest similar affections, have like talents, such as a real gift for music and dancing.

The shape of their faces and their gaits differ. V. is taller, heavier, and more vigorous than T. She has more confidence, and is perhaps a little more often the leader than T is.[1]

Both children have had chicken pox, pneumonia, and whooping cough. T. has had scarlet fever, and V. has had diphtheria.

The twins were also given the Otis advanced test. The indices of brightness were: T., 125; V., 125.

PAIR 24. SEX: MALE. AGE: 12 YEARS, 10 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
Donald S...	60	82½	181	149	82	Light brown	Hazel	83
David S....	59¾	81½	182	147	81	Light brown	Hazel	87

Donald is *right*-handed; David is *left*-handed, and the more afflicted with involuntary eye movements. Their complexions are fair.

[1] From their teacher.

[2] Derived from the Dearborn C test.

The boys are very genial and polite. Their laughter and smiles are similar; but Donald seems more frequently inclined both to laugh and to smile. They prefer each other's company to companionship with other boys.

Both boys have had measles and mumps, both of them are nervous, with eye twitching.

The twins were also given the Otis advanced test. The indices of brightness were: Donald, 71; David, 64. The I.Q. equivalents were: Donald, 90; David, 88.

PAIR 25. SEX: MALE. AGE: 8 YEARS, 10 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
E. H.	49½	52	171	146	85	Brown	Blue	115
W. H.	49¾	55	172	149	87	Brown	Blue	121

Their smile, voice, gait, teeth, laugh, nose configuration, ears, and expressions are almost identical. Both are in the same grade; both skipped a grade together. E. is *left*-handed; W. is *right*-handed. They seem to be very similar temperamentally and emotionally. Yet, as is true also of our most similar pairs of twins, they are

[1] Derived from the Dearborn A and Pintner-Cunningham tests.

easily distinguishable after a few moments. In this pair the most distinct physical difference is in the head shape and size.

E. and W. look, act, work, and dress alike. W. is a trifle taller and somewhat heavier. They carry themselves well in an identical manner and are *together* very self-reliant. They are inclined to mischief, but are always willing to tell the truth about anything that they have done. E. and W. are most firm and intimate friends, sharing every thought, action, and possession with each other.

Neither boy is self-conscious. They are equally ambitious, and persevere in doing the things that they are interested in. Both are good scholars; arithmetic is their strongest point. They do equally well in handwork and have original ideas of coloring and drawing. They are the first in the class to see a joke.

The boys live on a large milk farm and are very enthusiastic over the work there. They can describe how the cows are milked by machinery and the various processes in pasteurization. Both have a positive disgust for meat, and live on vegetables, fruits, and milk.[1]

The twins were also given the Otis primary test. The indices of brightness were: E., 142; W., 140. The I.Q. equivalents were: E., 117; W., 115.

[1] From their teacher.

PAIR 26. SEX: FEMALE. AGE: 9 YEARS, 3 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
Lydia B. ..	49¾	51	159	136	86	Black	Blue	94
Laur. B.	49¼	52	160	138	86	Black	Blue	97

Lydia is *left*-handed; Lauretta is *right*-handed. Both have extremely light complexions. They have similar marks on their faces, but the marks are on different sides of the face. The twins are in the 3rd grade.

Lauretta and Lydia are next to the youngest in a family of twelve children. One would notice the twins right away because they look so very much alike. At first glance one can see no difference between them, but on looking closer one sees that Lauretta's face is not so round as Lydia's. Lauretta is half an inch shorter and weighs two pounds more. They are always spotlessly clean and dress exactly alike even to the belt on the dress and little fancy pin.

Neither child is graceful as she walks along with head bent forward, and shoulders rounded. The moment they realize that they are the center of interest they become self-conscious.

Both are eager to learn, although Lauretta excels. Lydia will come to me in the morning, proud and happy, to tell me that Lauretta helped her with her arithmetic or in telling the time. Both do very well in spelling and tell excellent language stories. Strangely enough, each has a slight impediment in her speech which makes it almost impossible for either of them to sound certain

[1] Derived from the Dearborn A test.

consonants, especially "r." This of course makes them poor oral readers.

They work wonderfully well together, always choosing each other as companion during free hours. Only once have I seen discord. Lydia came up with tears in her eyes: "Miss ——, Lauretta is making my story on her desk, and I told it to her last night." I spoke to Lauretta. She realized that she was n't playing fair. She willingly made a new story.

It is strange that neither child can keep on the key in singing, but can read the notes well. The first of the school year they had very little control in cutting and other handwork, but they have improved and some of their work is sometimes chosen as the best. They carry home their school work, as they are ambitious and want to "get promoted."

In the school yard you might once in a while see them start a game, but never in the schoolroom do they show a desire to lead. When invited to do anything by the other children, at first they hang back but after a few moments gain courage. Lydia is the more shy.

During the first of the year both had a desire to bring little things, such as glass prisms, chalk, glass, to school and play with them on the sly. But after a few corrections they have coöperated and tried to be helpful, very seldom falling from grace. They are happy little girls, usually among the first to see the funny side of anything. They have a peculiar way of putting their upper teeth over their lower lip when they wish to laugh. The trick is especially marked in Lydia; very

seldom does she break into a hearty laugh without first doing it.

They don't seem to want to make chums of the other children, as they enjoy each other's company. As they have a sister in the fourth grade and one in the second, they have companions enough to play with. Their favorite games seem to be playing school and dolls. Whenever anyone gives them anything, even a broken doll, they are always eager to tell about it, for any little gift makes them extremely happy.[1]

The twins were also given the Otis primary test. The indices of brightness were: Lydia, 104; Lauretta, 96. The I.Q. equivalents were: Lydia, 102; Lauretta, 98.

PAIR 27. SEX: FEMALE. AGE: 16 YEARS, 9 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
C. P.	63½	121½	180	144	80	Brown	Brown	98
M. P.	64	128	181	145	80	Brown	Brown	98

Both of these twins have very light complexions, round faces, and large eyes.

PAIR 28. SEX: MALE. AGE: 16 YEARS, 3 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[3]
W. N.	68½	143	190	151	79	Yellow	Gray	96
C. N.	68½	148	192	153	80	Yellow	Gray	95

Both twins have big, narrow faces.

[1] From their teacher.

[2] Derived from the Terman group test.

[3] Derived from the Terman group test.

PAIR 29. SEX: MALE. AGE: 6 YEARS, 7 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.
Roy D. ...	47	49	179	144	80	Brown	Blue	98
Robert D. .	46½	47	178	143	80	Brown	Blue	100

Roy is *right*-handed; Robert is *left*-handed. They have the same facial freckle patterns. Their laughs and voices are very much alike.

Their voices are very similar, being rapid, loud, and husky monotones. Both boys are aggressive, Roy a bit more so than Robert. They are courageous, and have leadership qualities, but are poor in self-control as well as in motor control, in which Robert is especially weak. On the other hand their muscular strength and health are good; and so too are their postures. They have quite a little initiative for such young children.

Their handwork, like their motor control, is poor. They both walk rapidly, and with very similar coördination of movements. They find great pleasure in each other's company. I find much difficulty in distinguishing them and am constantly asking: "Is this Robert or Roy?"[2]

The twins were also given the Otis primary test. The indices of brightness were: Roy, 106; Robert, 110. The I.Q. equivalents were: Roy, 102; Robert, 104.

[1] Derived from the Pintner–Cunningham mental test.

[2] From their teacher.

PAIR 30. SEX: FEMALE. AGE: 7 YEARS, 9 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
Salv. P.	40½	38½	169	147	87	Black	Black	71
Sant. P.	39½	38	170	146	86	Black	Black	71

Both children are repeating the 1st grade, and are poor in all their work, equally inattentive, emotionally unstable and immature, and liable to cry on the slightest occasion.

The twins are very much alike in gait, appearance, gestures, and in timidity and bashfulness, and both have a cringing attitude.

PAIR 31. SEX: FEMALE. AGE: 9 YEARS, 9 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
M. O.	49	49	164	140	85	Brown	Gray	83
H. O.	49	48	163	140	85	Brown	Gray	82

The twins are in the 3rd grade.

They were also given the Otis primary test. The indices of brightness were: M., 66; H., 64. The I.Q. equivalents were: M., 86.4; H., 85.6.

PAIR 32. SEX: FEMALE. AGE: 8 YEARS, 9 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[3]
A. C.	49¼	53	171	142	83	Brown	Gray	78
H. C.	49	52	170	143	84	Brown	Gray	84

[1] Derived from the Dearborn A test.

[2] Derived from the Pintner-Cunningham and Dearborn A tests.

[3] Derived from the Dearborn A test.

A. is *right*-handed; H., is *left*-handed. Their voice, walking gait, and facial expression are very similar. They are in the 3rd grade.

It is difficult to control them; they have the same ungovernable tendency to be twittering constantly. They are both inattentive, and cannot concentrate. Both children are good singers and recite excellently. They are potentially good actresses, but poor scholars. (I can hardly distinguish them even by seating them in different parts of the classroom.) They are inseparable, as they are very much attached to each other.[1]

The twins were also given the Otis primary test. The indices of brightness were: A., 74; H., 68. The I.Q. equivalents were: A., 90; H., 87.

PAIR 33. SEX: MALE. AGE: 7 YEARS, 1 MONTH

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
S. O.	45	45	164	136	83	Black	Brown	98
J. O.	44½	48½	168	140	83	Black	Brown	98

J. is a little shorter, and a bit heavier than S.; but they look and act very much alike. Both have olive complexions, dark hair and eyes. Their voices are identical.

The twins were seated far apart early this school term, because they seemed to depend upon each other too much. They were bent on doing the same thing at the same time and in the same way. The boys have a

[1] From their teacher.

[2] Derived from the Otis primary test.

mild, good-natured disposition, and never sulk when corrected. They are courteous, coöperative, and kind. They always seek each other for partners in games and when lines are formed; they seem ill at ease when apart, as they have an intense mutual affection.

Both J. and S. are diligent, have a sense of fair play, are equally patient and persevering, and are fair leadership material. They seem to have two bodies, and but one mind.[1]

The indices of brightness were: S., 96; J., 96.

PAIR 34. SEX: MALE. AGE: 7 YEARS, 4 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
P. V.	45¼	46¾	171	139	81	Brown	Hazel	76
A. V.	45	44¼	174	140	80	Brown	Hazel	75

P. is *left*-handed; A. is *right*-handed.

Both boys are equally lacking in perseverance, patience, self-control, and self-consciousness. Neither boy has had any training, but seems to be innately most refined and courteous. Their muscular control is poor, and also their handwork, but their mental work is better. Their voices are very similar, and are full and clear. Their games, friends, and interests are the same. Both boys are full of play, and strong and healthy, but have no leadership qualities.[3]

The twins were also given the Otis primary test. The indices of brightness were: P., 100; A., 94. The I.Q.

[1] From their teachers.

[2] Derived from the Pintner-Cunningham and Dearborn A tests.

[3] From their principal and two teachers.

equivalents were: P., 100; A., 98. It is interesting to note how equally sub-normal both children were on the Dearborn A test, and how equally normal they were on the Otis primary test. The Dearborn A test involves much drawing, which in part depends upon motor control, in which the teacher noted their inability. The Otis primary test involves much verbal and abstract material, in which the twins were normal for their age. Thus even as early as seven years of age, there are evidently two types or kinds of intelligence, which cannot be measured by any one type of test.[1]

PAIR 35. SEX: FEMALE. AGE: 15 YEARS, 8 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
El. B.	65½	124	179	159	89	Dark brown	Black	87
Et. B.	65	117	181	157	87	Dark brown	Black	84½

El. is *right*-handed; Et. is *left*-handed. They are both in the 2nd year of high school, taking the same course of study and attaining approximately the same grades.

The I.Q.'s in the Dearborn C test were: El., 87; Et., 86. The I.Q.'s in the Terman test were: El., 87; Et., 83.

PAIR 36. SEX: FEMALE. AGE: 18 YEARS, 11 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[3]
G. D.	61	...	168	136	81	Brown	Gray	89
K. D.	60	...	173	139	80	Brown	Gray	87½

[1] The author is at present completing an experiment whose data demonstrate the above statement.

[2] Derived from the Dearborn C and Terman group tests.

[3] Derived from the Dearborn C and Terman group tests.

The twins are in the last year of high school. They are both excellent in domestic science, in which they are specializing, but are poor in courses in the art and science departments.

The I.Q.'s in the Dearborn C test were: G., 91; K., 89. The I.Q.'s in the Terman test were: G., 87; K., 86.

PAIR 37. SEX: MALE. AGE: 16 YEARS, 2 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
S. T.	64¼	124	200	145	72	Dark brown	Brown	105
A. T.	63½	126	197	147	75	Dark brown	Brown	105½

The twins are juniors in high school, taking the same courses. Their work and grades are usually the same. They both are especially good in algebra and geometry.

The I.Q.'s in the Dearborn C test were: S., 108; A., 110. The I.Q.'s in the Terman test were: S., 102; A., 101.

PAIR 38. SEX: FEMALE. AGE: 6 YEARS, 6 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
Marie M. ..	44¼	44½	178	141	79	Brown	Gray	87½
Margy M. .	44½	47	179	142	80	Brown	Gray	87

Marie is *right*-handed; Margy is *left*-handed.

The M. twins have the same quality of voice, laughter, and the same gait; their teeth are very similar. The twins were shown the accompanying little snapshots

[1] Derived from the Dearborn C and Terman group tests.

[2] Derived from the Dearborn A and Pintner-Cunningham tests.

separately and each thought her sister to be herself. Each child, when given a little change to buy candy, said: "No, we put it in the bank." [1]

The twins are considered to be nearly equal, or similar to each other, in courtesy, play spirit, qualities of leadership, self-control, self-reliance, self-consciousness, aggressiveness, poise, posture, voice, enthusiasm, tastes in foods, and in respect to games and playmates; and to

differ in spirit of coöperation, perseverance, patience, decision, and motor control, in all of which Marie has the advantage; Margy is more often sulky than Marie and is stubborn. Margy at times resents having someone else so very much like herself, and consciously took the contrary attitude to that which Marie adopted.[2]

The I.Q.'s in the Pintner–Cunningham test were: Marie, 85; Margy, 85. The I.Q.'s in the Dearborn A test were: Marie, 90; Margy, 90.

[1] From their principal. [2] From the principal and two teachers.

CHAPTER VIII

DATA ON SIMILAR TWINS LIVING IN DISSIMILAR ENVIRONMENTS

FOR gauging the relative contributions of heredity and environment to the individual, similar twins living in dissimilar environments afford the most interesting and significant approach. But unfortunately it is very difficult to find many such cases. The deep, natural affection that similar twins have for each other often acts to prevent the conditions which would normally lead to a separation. Chiefly on this account our data here are all too scanty.

The tremendous and permanent influence of heredity can be easily seen in cases of similar but separated twins, certain tendencies, tastes, and general mental ability and trend persisting despite marked differences in environmental situations and environmental stimuli.

The value of individual cases of separated, similar twins depends upon two factors, (1) the age at which the twins were separated, and (2) the length of time the twins have been separated. The pair of twins studied by Professor H. J. Muller, Pair 6 in this study, greatly excels in value in respect to both these criteria, for the twins were separated shortly after their birth, and were thirty-two years of age at the time the study was made upon them.

PAIR 1. SEX: FEMALE. AGE: 18 YEARS, 5 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
Myrtle M.	61½	111	183	146	80	Brown	Brown	94
Myrtiss M.	61½	111	186	147	79	Brown	Brown	98

These twins were separated when they were thirteen years of age, and were placed together again when fifteen; then separated again over a year ago. They have lived apart more than three years.

Their expressions, manners, and attitudes are very similar; likewise their voices, laughter, teeth, and all of their facial features.

Both formerly were compelled to wear glasses; neither wears them at present.

The twins are good in English and Civics in freshman high-school work. They both like cooking, but dislike sewing, and are poor at it. Both children have always liked music.

When the twins lived together they always wanted to do exactly the same things, and to have the same things; to dress exactly alike, and to go to the same places. Once, when they went to a store, one of them wished to show the other an article, and seeing her own reflection in a mirror, called to it, supposing it to be her sister. It was because the twins depended entirely on each other, doing the same things, feeling the same reactions, that it was thought best to separate them to prevent the merging of their personalities. The following paragraph

[1] Derived from the Dearborn C and Terman group tests.

was written before the sisters were separated, when they were thirteen years of age.

The matter of separating the twins is considered seriously, as the girls depend too much upon each other and have never developed wills of their own. Whatever is done by one, whether good or bad, is copied by the other, and any fault becomes less serious shared in common with the other twin. Because of the close resemblance between the girls and the fact of their dressing alike, it is impossible for the visitor to distinguish them, or to remember which traits belong to which twin. It is also difficult to know when any mistakes are made which twin is responsible; and both are praised and blamed alike. They are hardly ever spoken of separately, always looked upon as "the N. twins," each one being considered as only half a child.

The principal friend of each has always been the other. Their relationship is one of total and true democracy, for they are equal intrinsically, having similar tastes, abilities, and temperaments. Neither shows dominancy in relation to the other. They are equally patient, equally polite, and equally without a sense of humor. Myrtle is somewhat more enthusiastic and loquacious, and a bit more stubborn. Myrtiss has a little more ambition and appears to be a trifle cleverer. Both children are loyal, especially to each other. Their postures and (walking) carriages are nearly identical. The twins appear to differ neither more nor less since their separation.[1]

Both children have had the same diseases: chicken pox and measles.

[1] From a visitor of the Boston Children's Aid Society.

The twins were also given the Otis advanced test. The indices of brightness were: Myrtle, 87; Myrtiss, 81. The I.Q. equivalents were: Myrtle, 93; Myrtiss, 95.

PAIR 2. SEX: FEMALE. AGE: 12 YEARS, 7 MONTHS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
R. R.	57½	78½	181	141	78	Almost black	Hazel	89
B. R.	57¾	80	181	141	78	Almost black	Hazel	95

The children had been living in different homes for about three years when interviewed and tested. They were both in the 6th grade.

R. is *right*-handed; B. is *left*-handed. R., while taking the mental tests, kept her right little finger at her mouth when she was not writing, with her other forearm resting on test booklet, in semicircular fashion. B. had her left little finger at her mouth, with her right forearm resting on the test booklet.

The twins are very similar in facial features and expressions. They laugh alike, have identical voices, and stride in the same fashion. They seem in most ways to be the right and left sides of one person. They were separated on this account, in order that they might develop more individual personalities, instead of reflecting each other.

Both children like horseback riding; they dance in the same fashion. They dressed indentically, until they were separated. Their teeth are very similar in size,

[1] Derived from the Dearborn C and Terman group tests.

color, and configuration. Their complexions are highly alike. Both children are flat-footed.

The twins love each other very much; they are intensely affectionate to one another. To others they are never more than friendly. They are high-strung, alert, expressive, egotistical, active, strong-willed, mischievous. They have equal ability in use of language; they are equally graceful and rhythmic. Teachers have reported that the separated children exhibit the same type of misbehavior. But there has been some change in R. since their separation. She is less active and energetic than formerly. B., however, does not appear to have changed more than is consonant with three years of natural growth. Both children easily lose their temper; R. weeps when this occurs; B. cries and screams. B. has always been more assertive. They play well with other children, but formerly always wished to be with one another.[1]

The twins were also given the Otis advanced test. The indices of brightness were: R., 88; B., 84.

PAIR 3. SEX: FEMALE. AGE: 33 YEARS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[2]
H. Y.	66	110	177	152	86	Light brown	Blue	128½
A. Y.	66¼	124	183	153	84	Light brown	Blue	129½

[1] From a visitor of the Boston Children's Aid Society.

[2] Derived from the Dearborn C and Terman group tests.

The sisters have lived apart the last eleven years. From early childhood they have been very similar in most ways, but always distinctly individual; their dual personalities have never tended to merge and become identical.

In appearance, too, they have resembled each other closely, yet some patent differences have *always* existed. Their hair, eye, and skin colorations have approached identity, but A.'s eyes are larger. Their other features are very similar, yet the shapes of their heads and faces differ. A.'s head is larger, also her face.

Their voices are very similar; no one can tell one sister from the other over a telephone. Their manners and gestures are very much alike, and their mode of walking is identical. The shape, pattern, color, and size of their teeth are similar.

The sisters greatly resemble each other in dancing, playing tennis, and in other sports.

The I.Q.'s in the Dearborn C test were: H., 132; A., 131. The I.Q.'s in the Terman group test were: H., 125; A., 128.

The following interesting observations and comments were submitted by one of the twins, H. Y.

Differences between my Twin and Me

I know very well that there have always been differences between my twin and me. Some of these were inherited, like differences in disposition and temperament. Although our coloring, general appearance and figures are the same, our faces and eyes are different. My twin's face is shaped like my father's, while her eyes are like my mother's. My face is

shaped like my mother's, but I have eyes like my father's. My twin has mother's happy disposition and father's easy going ways. I have father's hard, reserved disposition and mother's conscientious ways.

We had all the childhood diseases together, so we were probably equally affected by those. When we got older, I had typhoid fever alone, and my twin had whooping cough for a second time with a touch of pneumonia. These two illnesses produced no apparent differences in us.

In school we always got about the same grades, leaving out of account teachers who were more interested in one than the other, or subjects in which one was more interested than the other. My twin liked physiology better than I did, while I liked arithmetic better than she did. Our marks reflected the difference in our interest.

While we were in college we chose different majors. My twin majored in art and economics, while I majored in mathematics and German. We chose these majors partly because of ignorance. If we were going through college again, my twin would probably major in art and physiology, while I would major in mathematics and economics. As we neared the end of our college course, my twin's interest leaned toward medicine, while I should have liked to study law. We had neither the energy nor the money to carry out our desires, but our intellectual interests still lean toward those two subjects.

My twin likes people who resemble me in character and disposition, while I like people who resemble her in these two respects. This difference in taste holds true both in regard to men and in regard to women. Consequently we have never suffered the misfortune of becoming interested in the same man. For instance my twin's husband doesn't interest me at all as a man, and he is very much like me in character and disposition.

Any differences that have come about in us since we grew up, like changes in taste or ideals, have been caused by men in whom we were interested. For instance my twin dresses to please her husband now, in a gaudier manner than she used to dress. I overcame my tendency to be easily shocked and

my great reserve toward people to please a man for whom I worked for two and one-half years and whom I admired very much for his education, intellect, and ability to get along with people. I am gradually regaining my old standards in these respects, however.

My twin and I still enjoy each other just as much as ever in spite of any differences that have come about in us. In fact we enjoy each other so much that my twin's husband is jealous of me at times. My twin notices some changes in me. She thinks I have changed for the better, which is consoling. I am not so sure that she has changed for the better. I liked her taste better before she was married.

My conclusion is that people are changed a bit by environment, but not unless they wish to be. An influence strong enough to create in us a desire to change has to reach some vital motive like love or ambition. In conclusion I should say that on the whole my twin and I are almost as much alike as we used to be before we were separated.

PAIR 4. SEX: FEMALE. AGE: 29 YEARS

	Height	Weight	Head length	Head width	Cephalic index	Hair coloration	Eye coloration	I.Q.[1]
A. G.	61½	120	186	142	76	Brown	Blue	100½
S. G.	61	134	190	144	76	Brown	Blue	97½

The twins have been separated the last eleven years. They were always easily distinguished by their mother, even when dressed identically, but sometimes mistaken for one another by their father. R. is *right*-handed; S. is *left*-handed. Their voices, laughter, gait, and facial expressions are still very similar; in fact, just as much alike as they were before their separation. A.'s eyes have always been smaller than S.'s, and until five years ago, when A. had typhoid fever, their weights were about the same.

[1] Derived from the Dearborn C and Terman group tests.

Neither twin, before or since their separation, has shown any unusual emotional traits. A. has always attempted to gain her point through sarcasm, S. by sulking.

The following paragraph was written by one of them.

> We appear to have the same amount of enthusiasm; neither of us is the least demonstrative. We are never subject to moods or regrets. Temperamentally we are very similar and have remained so despite the fact that I am a nurse, and my sister a wife and mother. Our tastes are very similar, although my sister has stronger likes and dislikes. In aggressiveness, ambition, courage, and leadership, I think I exceed. My twin is more self conscious, is better able to relax, and is more patient. We seem to be similar in respect to coöperativeness, loyalty, self control and perseverance. Our voices, posture and gait are very much alike. I have better motor control, but my sister is stronger and has more physical endurance.[1]

Both of the sisters wear glasses; they started using them about a year apart. Their complexions are identical, and their laughter and smiles are precisely the same.

They enjoy music and dancing, which they do in much the same manner. They enjoy the same amusements, recreations, and foods; their tastes in general are the same.

The I.Q.'s in the Dearborn C test were: A., 107; S., 103. The I.Q.'s in the Terman group test were: S., 92; A., 94.

[1] Written by the unmarried sister, who is the trained nurse.

PAIR 5. A BRIEF RÉSUMÉ OF THE H. TWINS (SEPARATED THREE YEARS) BY S. H.

Sarah H.	Mary H.
Born May 4, 1900	
Physique:	
1. Birth weight 6½ lbs. For years we have kept practically constant weight, never varying more than three pounds. (S. is heavier than M., and there is less than one-half inch variation in height.)	1. Birth weight 6 lbs.
2. Health always excellent except for minor diseases:	2. Rolled off nurse's lap when a few days old, back slightly injured, so had slight kidney trouble when young; outgrown in childhood. A bit weaker than S. This shown whenever engaged in physical combat. One day got the best of S. by biting her. From that time on able to hold own in any fight.
(*a*) Chicken pox (at 3 years).	
(*b*) Whooping cough (at 4 years).	
(*c*) Measles (at 8 or 9 years).	
(*d*) Mumps.	
(*e*) Smallpox vaccination (at 19 years).	
No other diseases; occasional colds.	
Identical traits:	
(*a*) Black hair.[1]	
(*b*) Blue-gray eyes.	
(*c*) Same build, S. slightly larger in frame.	
(*d*) Said to walk differently.	

[1] In childhood was dark brown (father blond and whole family gray in old age), constantly growing darker until black at present (all mother's family dark-haired, and white-haired in old age).

SIMILAR TWINS LIVING APART

Standing height: $61\frac{1}{4}$ in.
Sitting height: $32\frac{1}{4}$ in.
(stocking feet)

Weight:
now 100 lbs.
average 103 lbs.
maximum $107\frac{1}{2}$ lbs.

practically the same for both individuals.

Both are right-handed.

Mentality:

1. Equally brilliant. Graduated from high school 1917, same class. Near top of class throughout school, even from kindergarten. Ranks varied only a point or two or fraction at graduation. M. fifth, S. seventh in class. M. inclined to be literary. Always won any literary prizes, or speaking prizes, for which both tried.
2. Witty.
3. Logical.

Disposition:

Cheerful.

Experiences:

Same amount of travel. Same pets; both owned ponies when small.

Education:

Graduated
High school, 1917.
Lasell Seminary, 1919.
Mt. Holyoke College, 1923.

Tastes:

Like same kinds of pictures, music, plays, clothes, and jokes.

Example: Last year in New Haven I saw a fall coat in a store which I admired very much. I met M. in Boston later for a week-end (she was coming down from Maine, and I had not seen her for four months). She was planning to buy a fall coat and asked me to look at one she had selected at Chandler's. It was identically the same as that which I had admired in New Haven!

Talents:

Equal in sewing, playing the piano, riding horseback, and swimming. M. plays tennis better, having practiced more. Both are inclined to be artistic, draw, and make small things like place-cards. Sense of color is the same in both.

	Sarah H.	Mary H.
Occupations:		
	From July, 1923, to February, 1924, assistant serologist, Connecticut State Department of Health Laboratory, New Haven (Wassermann work and heteriology).	Publicity work for Yale University. Writes all "official" university publicity, gets out weekly university bulletin, interviews, and feature stories. (Was editor-in-chief of *Mount Holyoke News*, having worked up from being a reporter.)
	From February to June, 1924, assistant in physiology, Vassar College, Poughkeepsie, New York.	
	From August, 1924, pathological technician for Thorndike Memorial Laboratories for Medical Research, Boston City Hospital, Boston, Massachusetts.	

The response of the writer of the above account to the question "Are you and your sister as much alike as before your separation?" was an emphatic "yes."

PAIR 6

Professor H. J. Muller has studied in great detail a case of identical twins who were separated very early in life. Dr. East has made a summary of Professor Muller's study, which we shall quote.

These twin girls, B. and J., were born March 24, 1893, of American parents in a South Dakota mining camp. They remained with their mother, who did not nurse them, only two weeks. After this they were separated permanently, with the exception of one additional week in early infancy, and did not see or communicate with each other until eighteen years of age. B. was brought up by foster-parents engaged in mining and hauling. As a child she was usually out-of-doors

with the teams and had only four years of formal schooling, including nine months at a business school. At fifteen she engaged in clerical work, and since she has had an active business career in various places, including France, during and after the war. The foster-parents of J. were fairly well situated financially, owning a ranch and a road-house, and sent the girl through the grades and high school, the high school course being finished in three years. Later she had some summer university courses. J. has remained in the West, her career being that of a school-teacher. She married in 1915, when she was twenty-two years of age, and has one child, a boy.

B. was less vigorous than J. as a baby, but this was probably due in large part to improper food and to large doses of laudanum. In childhood B. was subject to a disorder of the stomach. She also contracted measles, mumps, chicken-pox, and typhoid. J. had no special stomach disorder, but contracted whooping-cough, measles, mumps, and scarlatina. Both suffered from backache, due to congenital shortness of the tendon of Achilles; both contracted tuberculosis when about eighteen (J. also having pneumonia), and both came near to a severe nervous breakdown a little later. Their physical peculiarities are practically identical.

Mentally both were active, talking at eight months, learning to read at six or seven, and reading a great deal in afterlife. They were out-of-door children, imaginative, somewhat tempestuous, but on the whole normally good-natured. B. obtained her education by her own forcefulness, J. obtained hers rather by accepting what was offered. They are interested in religion, but their intellect, rather than their emotions, rules. They are both normally gregarious, and though B. has never married, she has had plenty of attention from the male sex.

Here, then, are duplicate twins, as Muller demonstrates mathematically, fed, housed, and educated in wholly different manners, who are yet so similar that they are mistaken for each other, who have developed mentally in a similar

manner, who have experienced almost identical physical ills, and who show a strong community of interests.

Given the Army Alpha intelligence test and the Otis advanced intelligence test, they scored 156 and 153 respectively in the former, and 64 and 62 in the latter. These scores are so high that unless these tests have genetic significance, the chances are over 300 to 1 against there being such a coincidence in scores. Furthermore, it should be noted that the slightly higher ratings, though not statistically significant, were made by B., whose opportunities were less ample than those of J.[1]

PAIR 7

Mrs. Vera de Mott, of Battle Creek, Michigan, and her twin sister were separated when three years of age and have always lived apart, seeing each other at long intervals only, yet that peculiar affection common to identical twins has always existed between them, and their characteristics have been so similar that even their best friends cannot tell them apart when they meet.[2]

PAIR 8

For the first eighteen years of their lives, Rose and Louise Briot were always together, needing no other chums. Since then their lives have varied greatly. One is a widow and lives in the West near her children and grandchildren; the other is married but has no children and has lived always in Chicago.

Although their environment has been so different, the similarity between the twin sisters is in no way lessened. Their friends do not tell them apart any more easily, either when they see them or when they hear their voices over the telephone. As girls they often voiced each other's thoughts, and even now their letters cross repeatedly.[3]

[1] "Mental Traits and Heredity," *Journal of Heredity* (December, 1925), pp. 433–449.

[2] *Journal of Heredity* (December, 1919), pp. 387–398.

[3] *Ibid.*

PAIR 9

W. Richmond reports a remarkable case of dementia precox twins, who were separated when twenty-one years of age. At forty-three the twins show similar mental traits in their pathological deviations, and their physical symptoms and characteristics are very much alike.[1]

PAIR 10

Mr. Albert E. Wiggam describes another very interesting pair of similar twins who have been separated most of their lives. "It seems that they are just as much alike, in a general way at least, as if they had spent their lives together."[2]

Quoting the letter of one of the twins to Mr. Wiggam:

We are girl twins, aged twenty-five years, both married. I live in Alaska, while my sister lives in Saskatchewan, Canada. Unlike most twins who are always together, and who dress and talk the same, fate seems to have kept us apart nearly all our lives. We were not reared together and have not seen very much of each other, but for all that we have always been very fond of each other and are as alike as two peas in a pod. We look alike, act alike, talk alike, and talk is the main thing we do when together. We seem to catch each other's ideas perfectly and often both start to say the same thing at the same time.

My sister married quite young, several years before I did. We were reared under entirely different environments. Our mother and father separated when we were four years of age, and my sister was reared by a friend of my mother's people who had no children of her own. Consequently, she was

[1] *Amer. Jour. Psychiat.* (July, 1926), pp. 6, 161–174.

[2] *The Fruit of the Family Tree*, p. 131.

reared as an only child, while I was one of a large family of children, my mother having married again.

We had seen each other only once before my twin sister came to live with us for a year, at the age of fifteen, and we were surprised to see how much alike we were, our tastes being all but the same, in dress and manners, so that even our mother would often mistake us.

PAIR 11

Professor Newman has reported upon a pair of identical twin girls reared apart.

These girls were separated when eighteen months of age, and grew up for seventeen years, with the exception of a short time together at their tenth year, under the most widely unlike environments. One of the young ladies was reared in the crowded Chelsea district of London; the other matured in a small town in Ontario, Canada. In addition, the home environment of the English-reared twin was far poorer than that of her Canadian-domiciled sister.

In mentality as judged by the Stanford–Binet test there was considerable difference between the twins; expressed in terms of I. Q. this difference amounted to twelve points, being more than twice the average difference discovered to exist between fifty pairs of identical twins reared together.

But the twins were strikingly alike in temperamental traits as measured by the Downey Individual Will-Temperament Test. Likewise in the Kent–Rosanoff Association Test. and upon the Pressey X–O test, the girls were remarkably alike.[1]

Professor Newman, in discussing the results of the psychological tests, remarks that the mental differences between the sisters, although large, has a parallel among identical twins reared together. He found that ten per

[1] *Journal of Heredity* (February, 1929), pp. 49–64.

cent of identical twins reared together showed a difference in I.Q. (based on the Stanford–Binet) as great as, or greater than, did the sisters in question.

PAIR 12

Professor Newman has more recently reported upon another twin pair of young women, now twenty-seven years of age, who were separated when about eighteen months of age and remained apart until four years ago. Thus they have been separated completely for nineteen years of their lives. Professor Newman expressed the opinion that there was not the slightest doubt that this pair of twins belonged to the category of identical twins.[1]

The *milieu* of the separated sisters offers an interesting study. The social environments of the twins during their nineteen years of separation were quite similar. But their educational environments strikingly contrast, one of them attending school only through the 5th grade, while the other went through normal school. The results derived from this pair of twins must be considered in close relation to their similar social and dissimilar educational environments.

The difference in I.Q. between the twins, tested by the Stanford–Binet test, is twelve points, while Professor Newman discovered the average difference between fifty pairs of identical twins reared together was only five and three-tenths points. Hence this pair differ in

[1] *Journal of Heredity* (March, 1929), pp. 97–104.

I.Q. over twice as much as the average of identical twins reared together.

On the other hand, in regard to emotional and social attitudes, the resemblance between the sisters is marked, and stands out much more prominently than their differences. On the Pressey X–O test the sisters are both low or both high in the same parts of the test, while on the Woodworth–Mathews test the sisters differ but slightly more than the average difference among the fifty pairs of identical twins living together.

Professor Newman summarizes his conclusions by stating that educational and mental training obviously influenced the respective standing of the sisters, but that in contrast, all of the tests of emotional traits gave the impression that the twins were remarkably and unusually similar despite their separation of nineteen years.

CHAPTER IX

RESULTS: THEIR INTERPRETATION AND IMPLICATIONS

A CONSIDERABLE portion of the data predicated in the three preceding chapters cannot be expressed in quantitative form. But that portion of our material relating to height, weight, head length, head width, cephalic index, and intelligence quotient submits itself to quantitative presentation. Before tabulating these results it will be expedient to restate the comparisons and contrasts we propose to make:

1. Contrast the data found on dissimilar twins living in similar environment with the data found on similar twins living in similar environment. The differences discovered must be interpreted as almost wholly due to heredity.

2. Contrast the data found on similar twins living in similar environment with the data gathered on similar twins living in dissimilar environment. Any greater differences discovered among the latter must be largely attributed to environmental causes.

3. Contrast the data found on dissimilar twins living in similar environment with the data gathered on similar twins living in dissimilar environments. If the latter twins are more alike, despite the fact that they are responding to different environments, while the former type of twins is reacting to a like *milieu*, addi-

tional weighty evidence would be adduced in favor of hereditary factors as the chief determinants of mental, temperamental, and anthropometric qualities, traits, and measurements.

TABLE I

	Height inches	Weight pounds	Head length mm.	Head width mm.	Cephalic index mm.	Intelligence quotient points
Average difference of dissimilar twins in similar environment	1.87	7	5.98	3.5	2.3	13.8
Number of cases	*54*	*54*	*57*	*57*	*57*	*58*
Average difference of similar twins in similar environment	.4	2.6	1.2	1.6	.87	2.3
Number of cases	*38*	*30*	*38*	*38*	*38*	*38*
Ratio of average difference of dissimilar twins to similar twins in similar environment	1:4.7	1:2.7	1:4.9	1:2.2	1:2.6	1:6.0

INTERPRETATION OF TABLE I

Identical, or, as we prefer to call them, similar twins, differ much less than dissimilar twins in respect to each of the six measurements, despite the fact that the environments of both types were similar and that therefore environment can be eliminated as a causal factor in reference to the differences between members, greater in one type of twin than in the other.

The *ratio* of the average difference of dissimilar twins is greatest in respect to intelligence (six times) and least

in respect to head width and cephalic index. One plausible interpretation of this result is that the variation in mental differences among white human beings is much greater than the variations found in reference to head width and cephalic index.

We can safely conclude then that the greater average difference (amounting in the extreme case of I.Q. to six times as much) found among dissimilar twins is very largely, if not entirely, a result of innate and hereditary forces expressing themselves; or conversely, the greater likeness of similar twins is a function of their innate natures and cannot be explained as due to a greater similarity in environmental conditions — greater than the members of each pair of dissimilar twins received.

TABLE II

	Height inches	Weight pounds	Head length mm.	Head width mm.	Cephalic index mm.	Intelligence quotient points
Average difference of similar twins living in similar environment	.4	2.6	1.2	1.6	.87	2.3
Number of cases	*38*	*30*	*38*	*38*	*38*	*38*
Average difference of similar twins living in dissimilar environment	.4	6	3.2	1	*.75*	3.5
Number of cases	*5*	*5*	*4*	*4*	*4*	*4*
Ratio of average difference of separated similar twins to similar twins of similar environment	1:1	1:2.3	1:2.7	1:0.6	1:0.8	1:1.5

Interpretation of Table II

Although Table II *statistically* cannot be considered valid, as we have only five cases of separated similar twins, yet probably it is somewhat significant. We see that for four of the six comparisons in the bottom row, the ratio of differences is almost zero; only in the cases of weight differences and of head-length differences are the ratios of the separated twins differences high; and in the case of weight differences the explanation is certain. Of the five pairs of separated similar twins, two pairs are young ladies, *one* individual of each pair being not only married but also a mother.

Table III

	Height inches	Weight pounds	Head length mm.	Head width mm.	Cephalic index mm.	Intelligence quotient points
Average difference of dissimilar twins of similar environment	1.87	7	5.98	3.5	2.3	13.8
Number of cases	*54*	*54*	*57*	*57*	*57*	*58*
Average difference of similar twins of dissimilar environment	.4	6	3.2	1	.75	3.5
Number of cases	*5*	*5*	*4*	*4*	*4*	*4*
Ratio of average difference of dissimilar twins of similar environment to similar twins of dissimilar environment	1:4.7	1:1.17	1:1.87	1:3.5	1:3.0	1:3.94

INTERPRETATION AND IMPLICATIONS

As to greater differences in head length of the separated similar twins we can (1) refer to Table I where the ratio of average difference is greater for head length than for any other physical measurement, (2) refer to our study of cephalic indices, where in the case of the Russian Jews, the head length increased considerably in the first generation of American-born children.[1]

Interpretation of Table III

This table, like Table II, is not statistically valid, yet like the preceding table, it contains results of interest.

In this table contrasts are offered between both twins and their environments. Nevertheless in respect to each of the six measurements contrasted there are greater average differences among the dissimilar twins living in similar environments than among the separated similar twins; and for four of the six measurements the ratio is three or four times as great.

Let us return for a moment to Table I, and examine the bottom row more carefully. We have already concluded on page 141 that the greater likeness of similar twins is a function of their innate natures; it is almost entirely, if not exclusively, due to hereditary principles.

At least for the ninety-six pairs of twins in question in Table I we can affirm that heredity is about five times as important as environment in respect to differences in intelligence quotient; about four times as important in respect to differences in head length; about four times as important in respect to differences in height; two and

[1] *Journal of Physical Anthropology*, January, 1927.

seven-tenths times as important in respect to differences in weight; about two times as important in respect to differences in cephalic index; and about one and one-half times as important in respect to differences in head width. Thus the relative importance of heredity versus environment in explaining differences varies very significantly in respect to the particular trait or form of ability that is measured.[1]

Let us now inspect the middle row of Table I. The assertions of the preceding chapter are based on the assumption that *all* of the average differences discovered to exist between similar twins living in the same environment are a result of environmental influences. But this assumption attributes to the environment differences that may or may not be caused by environment; and probably are caused by both environment and heredity. That is, the differences between so-called identical twins are in part due to heredity.

The point at issue really amounts to this: "Why are there differences between very similar twins?" In an earlier chapter remarks were made on the relation between uniovular twinning and the two sides of every individual.[2] Each of us was once potentially a pair of twins which did not actualize as separate primordia; and with each of us there is some marked asymmetry in regard to one or more features, traits, or members of our

[1] These lower ratios are obtained if we concede *all* of the differences between the individuals of similar twin pairs to be determined by environment.

[2] See also pp. 22, 25, 26.

body. Occasionally, even, there are individuals who have one eye blue and the other brown.

Uniovular twins should be expected therefore to differ from each other in the same respects and to the same extent as the two sides of the body differ in the ordinary individual.[1] Hence we are overgenerous in allowing environment to account for the differences in the middle row of Table I. In other words the ratios expressed in the bottom row of this table are somewhat too small; in respect to the measurements in question. Upon these twins heredity is even more potent than our figures signify.[2]

From previous studies, especially those of Emily Dexter and of Merriman, the following correlations upon intelligence were secured:

On unselected twins of same sex	$r = +.80$
On unselected twins of unlike sex	$r = +.50$
On sibs	$r = +.50$

The correlation between the I.Q.'s of our thirty-eight pairs of selected similar twins is

$$r = +.97 \pm .012.$$

The correlation between the I.Q.'s of our selected dissimilar twins is

$$r = +.53 \pm .071.$$

It can be gleaned from these figures that the unselected twins of the same sex contain a considerable

[1] See also pp. 22, 25, 26.

[2] We have in no way affirmed or proceeded on the assumption that our "similar" twins were all uniovular twins. Probably nearly all of them were uniovular, but the fact is immaterial to our discussion.

proportion of dissimilar twins, resulting in the difference of a correlation of +.80 as compared with one of +.97. (Fisher has estimated that only 59 per cent of Lauterbach's same-sex twins are identical twins.)

It will be seen that our fifty-eight pairs of dissimilar twins correlate in a degree very closely resembling ordinary sibs. Since the heredity of dissimilar twins is the same as that of sibs, a similarity of their respective correlations would be expected.

Professor Lauterbach found in correlating the cephalic index of male twins (unselected) that the positive correlation, regardless of age, was as follows:

For male twins	r = +.63
For female twins	r = +.71
For twins of unlike sexes	r = +.59

Our own results are:

The cephalic indices of the similar twins	r = +.953
The cephalic indices of the dissimilar twins	r = +.587

It is interesting again to compare not only our two correlations, each with each, but both with Professor Lauterbach's results. The difference between our correlation on selected similar twins and his on unselected male twins and unselected female twins, +.32 and +.24, respectively, must be accounted for on the basis of dissimilar twins of the same sex in Dr. Lauterbach's groups.[1]

[1] R. A. Fisher, by complicated statistical methods, has computed that 59 per cent of Professor Lauterbach's same-sex twins were identical twins. See his article in *Genetics*, vol. X, November, 1925.

CHAPTER X

CONCLUSIONS

> It is the paradox and tragedy of high civilization that in the present and in all preceding ages, its tendency has been to destroy or eliminate just those mental superiorities by which it has been built up and which are essential for its maintenance and further progress. — WILLIAM MCDOUGALL, *Eugenics Review*, V, 287.

THE experimental portion of our essay has revealed certain general principles as well as adduced a number of facts. The preceding chapter summarized the facts and briefly interpreted them. In this short concluding chapter some of the principles emerging from the study will be stated.

I. The study reveals that there are methods of approaching the heredity-environment problem which permit the separation of the relative contributions of each, so as to measure roughly their respective values. The possibility of disentangling the effects of heredity and environment has been and is often denied.

II. The study demonstrates that heredity and environment both contribute to the intelligence and anthropomorphic qualities of the individual, but that their contributions are far from being equal. Neither the extreme hereditist nor the extreme environmentalist is correct, but the contribution of heredity is several times as important as that of environment.

III. The study has shown, moreover, that heredity and environment vary in their relative importance in relation to specific or general traits. Thus from our data it was seen that heredity was about five times as significant as environment in determining I.Q. differences between twins, while for weight, heredity was only about twice as potent in its causal effectiveness as environment. Our study did not quantitatively test emotional qualities, but from what scientists have discovered about impulsive and emotional processes, and their general positive correlation with intelligence, it is highly probable that in respect to these qualities heredity would be found to be from two to five times as potent as environment.

Furthermore, it should be added here that several experiments have demonstrated that education and training vary in their influence in proportion to the hereditary type with which they are dealing — the more intelligent the individual the more potent educational and general environmental influence. It may be stated then that the importance of environment increases roughly as we ascend the human scale. In other words, environment becomes more important as heredity becomes higher and more competent, paradoxical as this may seem. This truth again shows that heredity and environment are by no means intrinsically antagonistic.[1]

IV. But there is no doubt that today many of the environmental agencies of civilization are contributing

[1] Plato observed that environment is most effective when it operates on complex nature.

to "The Decline of the West," and that political wisdom can be garnered from a study of twins, and from other experimental studies of heredity and environment.

That all men are born unequal is a truth based upon facts. That modern environmental agencies and conditions permit and encourage the survival and multiplication of the poorest quarter of mankind, and penalize and discourage the reproduction of the best quarter is a thesis that has almost reached the status of a truth. And all the time the social heritage grows more and more complex, while the inheritance of the individuals who are to assimilate its treasures is almost certainly declining. Mankind, or rather Western mankind, is at a cross-road, in addition to the one so vividly described by Professor East. Our social heritage is becoming increasingly a burden to a large part of mankind. Yet man cannot return to barbarism or to savagery. Civilization should be and can be continued if from age to age society improves the nature of man as well as his environment.

We could not better end our essay than by quoting the following from Professor Conklin:

> Our psychical, social and moral environment has come to us from the past with ever increasing increments, every age standing on the shoulders of the preceding one. The aspirations, impulses, responsibilities of modern life have become enormous and our inherited natures and abilities have not essentially improved. Social heredity has outrun germinal heredity and the intellectual, social and moral responsibilities of our times are too great for many men. Civilization is a strenuous affair, with impulses and compulsions which are

difficult for the primitive man to fulfill, and many of us are hereditarily primitive men. . . . We are approaching the time when one or the other must give way; either the responsibilities of life must be reduced and the march of civilization stayed, or a better race of men, with greater hereditary abilities, must be bred.[1]

[1] *Heredity and Environment,* pp. 362–363.

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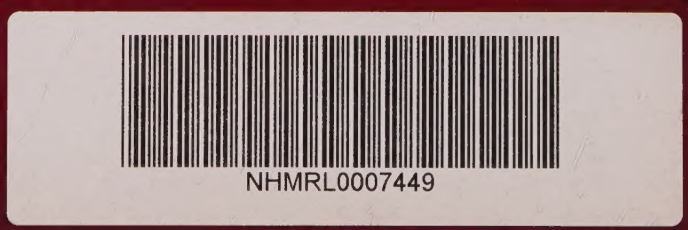
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